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GUIDELINES FOR THE DISPOSAL OF SMALL QUANTITIES OF UNUSED PESTICIDES

MIDWEST RESEARCH INSTITUTE

PREPARED FOR
NATIONAL ENVIRONMENTAL RESEARCH CENTER

JUNE 1975

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This study has compiled and organized information that will be useful to responsible authorities in advising the layman (particularly the homeowner and small farmer) how to dispose properly of small amounts of surplus and unwanted pesticides and pesticide containers, and in treating pesticide spills. The report brings together available information on pesticide disposal methods and on over 550 individual pesticides, and evaluates this information in terms of the experience and equipment that the average layman has. Fourteen pesticide disposal procedures are described and procedures for disposal of containers and cleanup and treatment of spills are included. Preferred and alternate disposal procedures are recommended for over 550 pesticides. The report includes a cross-index of over 1,600 pesticide names, tables showing the chemical composition and properties pertinent to disposal of the selected pesticides and bibliography of 166 references.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
*Pesticides	Decontamination	Pesticide spills	13B
*Herbicides	Incinerators	Pesticide manual	
*Insecticides	Neutralizing	Pesticide disposal	
*Disposal	Oxidation	Pesticide burial	
*Manuals	Reduction (chemistry)	Pesticide incineration	
Waste treatment	Degradation	Pesticide treatment	

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GUIDELINES FOR THE DISPOSAL OF SMALL QUANTITIES OF UNUSED PESTICIDES

EPA REPORT NO. EPA-670/2-75-057, June 1975

ERRATA

The following editing and printing errors have been noted; they pertain primarily to internal cross-referencing of pages, Appendices, and Parts:

Page	Line	Error	Correction
4	27	Phenoxyes	Phenols
10	8	four appendices	five appendices
31	3	subtitle missing	Pesticides
31	6	Part II	Part B
55	6	pages 10 and 17	pages 12 and 20
67	13	Figure 1, p. 27	Figure 1, p. 29
73	34	(page 68)	(page 69)
74	13	(page 65)	(page 67)
102	8	p. 113	p. 115
115	8	p. 38	p. 40
124	13	p. 123	p. 125
171	15	page 15	page 17
185	8	Part I	Part A
186		Caption cut off	Figure 4 - Simulated Pesticide Label
187	3	(p. 177)	(p. 189)
187	10	page 177	page 189
187	14	page 212	page 224
187	40	Appendices A and B	Appendices B and C
188	1	Part I, p. 21 and in Appendix D	Part A, p. 23, and in Appendix E
188	13	p. 292	p. 304
189	7	Section VII	Section XI
228 thru 296		All page numbers in right hand column, "Additional Infortion Page No."	Add 2 to each page no. EXCEPT FOR THE FOLLOWING ITEMS:

Page	Common Name Chemical Name	Error	Correction
228	Acrylonitrile	p. 98	p. 101
236	Butonate	p. 130	p. 67
238	Carbon disulfide	p. 128	p. 125
239	Carboxin	p. 80	p. 85
240	Chlorobromuron	p. 109	p. 89
245	Cypromid	p. 80	p. 85
257	Endothall	p. 130 is correct	
261	Ferbam	p. 83	p. 82
271	Methyl nonyl ketone	xxx	p. 132
274	Nabam	p. 83	p. 82
274	Naphthoxy-acetic acid	Identification	B-Naphthoxy-acetic acid
275	Niacide	p. 83	p. 82
277	Oxycarboxin	p. 80	p. 85
278	Paris Green	p. 56	p. 59
283	Polyethylene polysulfide	p. 123 is correct	
283	Propachlor	p. 80	p. 85
284	Propanil	p. 80	p. 85
285	Prynachlor	p. 80	p. 85
287	Simazine	p. 81	p. 91
293	D-Trans Allethrin (R)	Incorrectly alphabetized	Transfer to p. 256
296	Zineb	p. 83	p. 82
296	Ziran	p. 83	p. 82

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Page	Line	Error	Correction
298	Table 12	All page numbers	Add 4 to each page no.
298	29	Part I, Appendix A	Part A, Appendix B
298	33	Appendix B	Appendix C
300	1	Procedures 6 through 10:	Procedures 7 through 10:
305	1	p. 21	p. 23

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GUIDELINES FOR THE DISPOSAL OF SMALL QUANTITIES OF UNUSED PESTICIDES

Part A: Pesticides, Pesticide Chemistry, and Pesticide Disposal
Part B: Methods for the Disposal of Unused or Spilled Pesticides

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The National Environmental Research Center--Cincinnati has reviewed this report and approved its publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endoresement or recommendation for use.

FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environmental Research Centers provide this multidisciplinary focus through programs engaged in

- Studies on the effects of environmental contaminants on man and the biosphere, and
- A search for ways to prevent contamination and to recycle valuable resources.

Surplus or unwanted pesticides pose safety hazards to the public and potential sources of needless environmental contamination if they are disposed of improperly. In this study available information has been drawn together to assist public officials in advising the public on problems of disposing of small quantities of unused pesticides or pesticide containers and of treating spilled pesticides.

A. W. Breidenbach, Ph.D.
Director
National Environmental
Research Center-Cincinnati

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The project team has consisted of Dr. Edward W. Lawless, who served as project leader, Mr. Thomas L. Ferguson, Dr. Alfred F. Meiners, and Miss Anne C. Aspoas. Dr. Daniel J. McCaustland and Dr. Eugene G. Podrebarac served as in-house technical consultants and Miss Meredith Reichel assisted in the literature search which was conducted primarily in 1971 and 1972. Dr. Rosmarie von Rümker supplied helpful sources of information during the program. The program was conducted under the general supervision of Dr. H. M. Hubbard, Director of MRI's Physical Sciences Division. The program had MRI Project No. 3552-C.

The information and recommendations presented herein are intended as guides for agencies and persons who are responsible for furnishing information to the public on safe disposal of unused or spilled pesticides and pesticide containers. The sources of this information are believed to be reliable and the procedures described are believed to be safe. However, no warranty, guarantee or representation is made concerning the accuracy or sufficiency of any information and Midwest Research Institute does not assume responsibility in connection with any accidents or injuries which might result from using procedures described herein. Furthermore, other or additional precautionary measures of disposal procedures may be required because of particular conditions or applicable local, state or federal law, some of which have been revised since the initial research on this study was completed.

ABSTRACT

A study has been made of methods for the detoxification and disposal of pesticides. The objective was to assemble information that will be useful to responsible authorities in advising the layman (particularly the homeowner and small farmer) how to: (a) dispose of small amounts of unwanted, surplus, or unused pesticides; (b) treat pesticide spills of small proportions; and (c) dispose of empty pesticide containers, in a manner that presents minimum hazard to himself and to the environment. An acceptable method must be adaptable for use by the layman with the chemicals and equipment which he has available.

The program was of wide scope: a goal was to bring together information on the disposal of all pesticides which are, or have recently been, commercially available in the United States. Tasks in the program were:

* To compile, analyze and evaluate information on pesticide disposal, and to organize it in a broadly useful form as a reference source.

* To select either the best methods for direct disposal of pesticides by the layman, or the best alternative procedures for placing the pesticides in the hands of responsible persons who will see that they are disposed of properly.

* To outline procedures or to make recommendations that the layman can use in disposing of pesticides.

A total of 550 chemicals that have been sold commercially as pesticides were identified, and information was compiled from the technical literature on their pesticidal uses and properties; their physical, toxicological and environmental properties; and their detoxification and degradation chemistries. These pesticides were grouped in seven major categories and over 40 subcategories according to chemical classes, as an aid in organizing the available information, in helping to bridge the many information gaps, and in determining suitable disposal procedures for each pesticide. Fourteen disposal procedures are described which are believed to be suitable for use by the layman with guidance from a responsible official. Separate procedures describe the proper disposal of containers and the cleanup and treatment of spills.

Over 25% of the pesticides are so hazardous to man or the environment or the state of knowledge on their degradation is so incomplete, that the recommended disposal procedure is for the layman to place his pesticide in the hands of a professional rather than to attempt to detoxify it himself, i.e,

turn it in to a collection center, return it to a supplier, or transfer it to an industrial waste service. For all but the most toxic of these pesticides, however, alternative disposal procedures have been listed. Another group of approximately 30% of the pesticides are so environmentally persistent, thermally stable, or resistant to chemical degradation, that the preferred disposal procedure is incineration in efficient equipment of a type not normally owned by a layman. Alternate disposal procedures have also been suggested for many pesticides of this group. For the remaining 45% of the pesticides, disposal procedures are recommended which the layman can use himself: chemical detoxification is suitable for 15% of the total and either burning, ground burial, ground-surface disposal, dilution, or release to the air may be employed for 30% of the total. Documented examples of the demonstrated effective and safe use of these procedures for specific pesticide chemicals and pesticide formulations were generally unavailable, however, and a major recommendation is that such studies be conducted.

This report also contains a cross-index of pesticide names which contains over 1,600 entries, tables showing the chemical composition and properties pertinent to disposal for the pesticidal chemicals, a review of the literature on degradation and disposal for the various classes of pesticides, and 166 references.

The report is in two parts. Part A summarizes information on the kinds of disposal problems that pesticides can pose and the results of previous disposal studies. Part B contains the cross-index of names, the reference charts of property data and 550 pesticides, and the disposal procedures.

This report is intended to serve as a source of information for Regional EPA officials, county agents, public health service authorities, etc., who are responsible for supplying information to the layman. It is not intended for direct use by the individual layman.

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CONCLUSIONS

At least 550 different chemicals have been sold commercially in the United States for use as pesticides, but a far larger number of pesticide products are on the market for the following reasons: (a) a chemical may be "formulated" with other ingredients in different physical forms and in different strengths for different applications; (b) two or more pesticidal chemicals may be mixed to meet specific use requirements. About 8,000 different "formulations" are available and over 500 products contain two or more "active ingredients" each. Each company that markets a pesticidal product under its own name must have a registered "label" for it: the U.S. Department of Agriculture has registered over 50,000 labels for interstate shipments and the states have registered thousands of other labels for intrastate sale. Thus, the variety of pesticidal products that the layman may wish to dispose of is extremely large. The multiplicity and complexity of formulated pesticide products, the significant information gaps which exist at present on the degradation and hazards of pesticides, and the variations in local regulations preclude assignment of specific preferred disposal procedures for all pesticide products on the market.

The present study has focused on methods for the safe disposal of unwanted small amounts (less than 5 gal. or 50 lb) of the 550 active ingredients, and of empty containers in the possession of the public. Major conclusions of the study are as follows:

1. For pesticides of a very hazardous or persistent nature (such as parathion and mercury compounds), or for a few pesticides for which the state of knowledge on degradation is very limited, the preferred procedure for the layman is to place them in the hands of proper authorities or trained professionals for disposal, rather than to attempt to detoxify them by himself. About 25% of all the pesticides are in this category.

2. For pesticides that are not readily degraded (such as the persistent, chlorinated hydrocarbons, DDT and aldrin), the only completely satisfactory disposal method is incineration at high temperatures in equipment which contains an efficient wet scrubber and liquid waste disposal system, e.g., at a central disposal site. About 30% of all the pesticides are in this category.

3. Chemical reactions can be utilized by the layman to degrade or detoxify about 15% of the pesticides; limitations in the use of chemical degradation reactions include: (a) sufficient information is often unavailable on the chemical reactions of a specific pesticide to assure that potential disposal procedures would convert it rapidly, completely and safely into unobjectionable products; the practical disposal procedures given herein had to be based primarily

on data for reactions under much different, idealized conditions; (b) reactions which degrade pesticides to a pesticidally inactive form may leave them in a form which is not environmentally safe, or may even produce a mixture which is more toxic or hazardous to humans; (c) the reaction mixtures must be subsequently disposed by dumping, burial, discharge, or combustion methods.

4. For about 30% of the pesticides of low toxicity and persistence (such as pyrethrins or malathion), either direct ground disposal, dilution/discharge, or burning by the layman according to the guidelines established herein would be reasonably unobjectionable and would be preferable in most communities to available alternatives, such as long-term storage in a shed or garage.

5. When only very small amounts (a few ounces) of pesticide are involved, the layman's most efficient and safest course in most instances would be to dispose of the unwanted material by methods which closely approximate the directions for use, e.g., spray on the ground, or alternatively simply bury or spread on the ground. (Exceptions to this practice would be the extremely toxic pesticides such as parathion or sodium fluoroacetate and pesticides for which all use has been banned.)

6. If all disposal procedures which involve the use of ground burial, dumping, dilution/discharge, incineration, and "apply as directed" methods are rigorously excluded for substances or mixtures which have environmental hazard, the layman would hardly be able to dispose of a single pesticide by himself. On the other hand, although all of these methods have certain environmental drawbacks, they can be incorporated into disposal procedures for small amounts of pesticides without serious environmental damage, and with a net increase in safety to the public.

7. Safe disposal procedures are most urgently needed for those pesticides that do not have acceptable disposal procedures at present and are either: (a) extremely dangerous to man or wildlife because of their high toxicity; (b) not, or only slowly degraded to nontoxic products in the environment; or (c) produced in the largest quantities. Pesticides in these categories include the organomercury and organoarsenic compounds, thallium sulfate, Diazinon,® methyl parathion, parathion, phorate, maneb, alachlor, CDAA, propachlor, atrazine, DDT, heptachlor, toxaphene, lindane, chloramben, 2,4-D, 2,4,5-T, aldrin, chlordane, endrin, pentachlorophenol and 2,4,6-trichlorophenol.

SECTION II

RECOMMENDATIONS

Four major recommendations are made as follows and the first of these is further outlined below.

* Fundamental and practical studies of the degradation of pesticides should be greatly expanded. The disposal procedures recommended herein should be experimentally evaluated.

* The disposal of mixed pesticides should receive greater attention.

* Positive statements regarding the disposal of unwanted quantities of pesticides and empty containers should be added to the pesticide container label.

* A system of regional centers for the safe collection and disposal of hazardous materials, operated by trained personnel, is much in need and the government's development efforts should be expedited.

Ultimate disposal procedures for use by the layman were not recommended for 55% of the pesticides studied in this program primarily because of inadequacies in the available data. In order to achieve environmentally safe and convenient pesticide-disposal methods, either for the layman or for trained technical personnel, new and improved procedures based on fundamental studies of the degradation chemistries of pesticides must be developed. New concepts are required in order to achieve effective disposal for some pesticides; for example, new chemical methods are required for converting metallic and organometallic pesticides to less toxic materials which can then be safely disposed of. For other pesticides, more specific and complete data concerning detoxification reactions such as hydrolysis, oxidation, and thermal decomposition are required.

The pesticides which are most urgently in need of detoxification/disposal studies are those for which no acceptable disposal procedure is available and which have one or more of the following characteristics: (1) pesticides which are extremely dangerous because of their toxicity to man or wildlife; (2) pesticides which are not degraded, or are very slowly degraded, to nontoxic products in the environment; or (3) those pesticides which are produced in the largest quantities.

On the basis of these criteria, 24 pesticides have been selected as being most in need of safe and effective disposal procedures as shown in Table 1. The selected pesticides can be divided into groups according to proposed detoxification procedures, as discussed below.

TABLE 1

PESTICIDES FOR WHICH CHEMICAL DETOXIFICATION TECHNIQUES ARE MOST URGENTLY NEEDED

Chemical Classification	Specific Pesticide	Basis of Need[a]
Organomercury compounds	PMA (phenylmercuric acetate)	1,2
Organoarsenic compounds	DSMA (disodium methanearsonate)	1,2
Thallium compounds	Thallium sulfate	1,2
Organophosphorus compounds	Diazinon®	1,3
Phosphorothioates	Methyl parathion	1,3
	Parathion	1,3
Phosphorodithioates	Phorate	1,3
Dithiocarbamates	Maneb	3
Amides	Alachlor	3
	CDAA	3
	Propachlor	3
Triazines	Atrazine	3
Organochlorine compounds		
DDT family	DDT	1,2,3
Aldrin-toxaphene group	Aldrin	1,2
	Chlordane	2,3
	Endrin	1
	Heptachlor	1,2,3
	Toxaphene	1,2,3
Alicyclic	Lindane	1,2
Phenoxyes	PCP (pentachlorophenol)	1,2,3
	2,4,6-Trichlorophenol	3
Phenoxies	2,4-D	3
	2,4,5-T	3
Benzoic acids	Chloramben	3

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[a] The numbers refer to the primary reasons for selection as follows: (1) high toxicity to man and wildlife; (2) persistence in the environment; and (3) large production.

Organochlorine-pesticides: (DDT, chlorophenoxy compounds, chlorinated aliphatic and aromatic compounds, and compounds related to aldrin and toxaphene.) Although many publications discuss the decomposition and chemical degradation of these pesticides, effective and practical detoxification/disposal procedures for most of them are unknown.

At the present time, the only acceptable disposal procedure for these pesticides is incineration. However, in most cases, complex incineration equipment is required in order to assure that sufficiently high temperatures are developed, and to prevent atmospheric contamination by combustion products. Furthermore, incineration is practical only on a very large scale and is unsuited to the small batch operations which characterize most pesticide disposal situations.

We recommend that a study be made of other techniques for the practical disposal of these pesticides. In particular, we recommend that a study be made of a disposal procedure which employs both hydrolysis and oxidation. Although most of the organochlorine pesticides are not effectively detoxified by ordinary hydrolytic or oxidative degradation reactions, we believe that under more severe conditions (for example, at higher temperatures and pressures), the degradation reactions could be "forced" to proceed at acceptable rates. We recommend that research on this aspect of the problem be initiated in order to develop a technique for effectively converting the chlorine-containing pesticides to relatively harmless products by means of a simple procedure which would utilize inexpensive equipment, and result in no air-pollution problems. A major advantage of a disposal method of this kind is that it would also be applicable to many other pesticides known to be susceptible to oxidation and/or hydrolysis.

The heavy-metal pesticides: (Mercury, arsenic and thallium compounds.) These pesticides are highly toxic, persist permanently in the environment as heavy-metal compounds, and have had many important use registrations cancelled. For these pesticides, we recommend decontamination studies which involve conversion of the pesticide to relatively nontoxic, insoluble, naturally occurring compounds of the metal.

Disposal studies of this kind would include an examination of chemical methods for cleaving organometallic bonds of organomercury and organoarsenic compounds. Although practical chemical methods for accomplishing this reaction appear attainable, very little research of this kind has been reported. (The accent has been on producing, not breaking, the carbon-metal bond.) Similarly, the toxicity of many inorganic heavy-metal compounds can be greatly reduced by converting them to insoluble materials, but until now, there has been no impetus for research of this kind.

Hydrolyzable and oxidizable pesticides: (Organophosphorus compounds, amides, dithiocarbamates, and others.) Many pesticides in this classification are known to be effectively detoxified by hydrolysis and/or oxidation. However, specific reaction conditions (reaction times, concentrations, solvents, etc.) are lacking in many cases. We recommend that these data be obtained. We further recommend that a study be made of the practical utility of known decontaminating agents, especially reagents similar to those developed for the detoxification of chemical warfare agents. These agents, which were developed for the armed services, consist of powerful hydrolyzing and oxidizing chemicals, commonly dispersed in a solvent media which is highly conducive to the detoxification reaction. These decontaminating agents can be prepared cheaply, and some are now available as surplus materials.

PART A: PESTICIDES, PESTICIDE CHEMISTRY, AND PESTICIDE DISPOSAL

SECTION III

INTRODUCTION

The Environmental Protection Agency (EPA), through its responsibilities for maintenance of environmental quality, and the Office of Research and development through its general concern for hazardous materials entering our nation's waters, air and soil, are interested in pesticides. A particular problem is the disposal of small quantities of unwanted, surplus, or unused pesticides. Considerable attention has been given recently to the detoxification, prior to disposal, of sizable amounts of pesticides such as the herbicides returned from Vietnam. Some attention has also been given to the smaller amounts of unused pesticides at the consumer level and, in a few communities, specific pesticides such as DDT have been collected by authorities and safely disposed of by proven procedures. In general, however, the conscientious layman has considerable difficulty deciding what constitutes a safe and nonpolluting method for disposing of unwanted pesticides. Similarly, quantities of spilled pesticides or quantities left in "empty" containers are safety and environmental hazards. In all these cases, pesticides that enter the environment contribute to the overall pollution burden without yielding the benefits normally derived from their approved use.

The Environmental Protection Agency contracted with Midwest Research Institute to help provide guidance to the general public for the disposal of small quantities of unused or spilled pesticides and the cleanup and disposal of pesticide containers.

The ultimate objective of this research program is to assemble a manual that is useful to responsible authorities in helping the layman (particularly the homeowner and small farmer) in disposing of unwanted or spilled pesticides and empty pesticide containers in a manner that presents minimum hazard to himself and to the environment. A goal of the program has been to bring together information on the disposal of pesticides which are, or have recently been, commercially available. Tasks in the program are:

* To compile, analyze and evaluate information on pesticide disposal and to organize it in a broadly useful form as a reference source.

* To select either the best methods for direct disposal of pesticides by the layman or the best alternative procedures for placing the pesticides in the hands of a responsible person who will see that they are disposed of properly.

* To outline procedures or to make recommendations that the layman can use in disposing of pesticides.

The Final Report of this study is divided into two parts and is intended to serve several purposes. Part A contains background information on the purpose of the study, the study approach, a discussion of important aspects of the problems of pesticide disposal (in general and by the layman), and a review of the literature on the detoxification, degradation, decontamination, or disposal of the 550 pesticides which were identified as having been commercially available during the past 20 years. Part A also contains complete references for the report, and four appendices.

Part B is a manual that describes the steps to follow in disposing of each one of the 550 pesticide chemicals. It contains a cross-index of common, chemical and trade names for pesticides, from which the user can determine the name used in this manual for his pesticide. He can then find further information on the properties and degradation chemistry of the pesticide involved, and the disposal procedure which appears most suited to the disposal of the particular pesticide.

This report is intended to serve as a source of information for, and to give guidelines to, agencies or persons (such as Regional EPA officials, county agents, public health service authorities, etc.) who are responsible for supplying information to the layman. It is not intended for direct use by the individual layman. It is intended also as a source of information to those who are conducting research or planning R&D concerning the chemical degradation of pesticides.

SECTION IV

THE STUDY APPROACH

The study approach had several phases. Central to our approach has been the concept that the contract final report would be used primarily by responsible local authorities and persons with some technical training to find information on: (a) the disposal chemistry; and (b) the environmental and personal hazards of a pesticide which a layman wants to dispose of and has inquired about. The authorities can then advise the layman on the best course of action or recommend and supply directions for a specific disposal procedure. The phases of the study approach include:

- Development of a general data base. A search was made of the technical literature for information on pesticides, their properties, and their waste disposal aspects.

- Selection of pesticides for consideration. A goal was set to bring together information on all pesticides which are, or have recently been, commercially available. A cross-index of pesticide names was prepared.

- A review of the properties of pesticides and their formulations pertinent to disposal. Charts and tables describing the properties and hazards of pesticides were collected or prepared.

- A review and evaluation of the literature on the chemistry of the degradation, detoxification, decontamination, and destruction of pesticides. In order to accomplish this evaluation, a pesticide classification system was developed in which the pesticides were grouped according to chemical class or dominant functional group present.

- Analysis of information on disposal methods and description of general procedures suitable for use by the layman with limited experience, equipment, and supplies.

- Recommendation of the best available procedure for each selected pesticide, based on an analysis of the information on pesticide degradation and properties.

Certain of these phases require a more extended discussion, which follows.

Selection of Pesticides

Concerted effort was made to develop a comprehensive and accurate list of all the significant pesticides which are currently, or have been within the past 20 years, commercially available in the United States. A primary source of entries for this list was the article in Chemical Week by Neumeyer, Gibbons, and Trask,[1a] but this source was supplemented by several others.[1b-12] Extensive cross-checking was required to eliminate duplications (a compound often carries two or more names) and to correct numerous errors in some of these compilations. Five-hundred and fifty pesticides were thereby identifed with the source of entries as shown in Table 2.

TABLE 2

REFERENCE SOURCES FOR IDENTIFICATION OF PESTICIDES

	Total Number of Pesticides Listed	Number of New Entries Selected
Neumeyer, Gibbons and Trask[1]	380	380
American National Standards Institute[2]	116	30
U.S. Tariff Commission (1968-1970)[3,4]	258	36
Herbicide Handbook[5]	117	8
Kenaga and Allison[6]	48	40[a]
Federal Register[7]	~ 400	19
Johnson[1b]	335	37
Pesticide Manual (British)[8]	537	--[b]
Caswell[9]	> 1,900	--[b]
Pesticide Register by G. L. Mack[10]	1,078	--[b]
Pesticide Index[11]	1,537	--[b]

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[a] Insecticides listed as "commercially available," including 21 which are imported; this list does not include eight compounds listed as "attractants" which are little used, have generally low toxicities, and pose little pollution hazard.

[b] Used primarily for cross-checking.

A much smaller number could have been chosen: for example, only those pesticides of major production volumes, or only those for which registrations have been cancelled. The larger number was chosen because of several factors:

* Pesticides listed in the "Top 20" by production can change rather rapidly because of cancelled registrations, new products, etc.

* The list of cancelled registrations is growing rapidly, but not all uses are necessarily cancelled for a given pesticide.

* Most of the pesticides that have had all uses cancelled are relatively low-volume but high-hazard items.

* Any registered pesticide may be a candidate for disposal when the owner no longer wants it, e.g., when he moves or otherwise loses the need; when he adopts a safer, cheaper, or more effective pesticide, a different formulation, or a different method of application; or when his leftover pesticide becomes contaminated or decomposes, or when the container rusts.

* The mammalian toxicity, persistence in the environment, and effect on fish or wildlife, all affect the pollution potential.

This large number of commercially available pesticides was selected to make this final report as widely useful as possible.

The Data Base for Disposal Technology

The initial data base for this program was compiled by: a general literature search for pesticide waste-disposal technology; contacts with organizations either having responsibilities or conducting research related to pesticide and container disposal; and contacts with the pesticide-manufacturing industry. The literature included Water Resources Research Abstracts, Biological and Agricultural Index, Bibliography of Agriculture, Air Pollution Abstracts, and Chemical Abstracts. A complete search of Chemical Abstracts was not made for each of the 550 pesticides; a spot-check on 20 major pesticides in an early phase of the program indicated that such a search would yield extremely small amounts of information in proportion to the amount of time required. (Subsequently, additional searches of Chemical Abstracts were made for a few compounds of special interest.) A number of pamphlets, guidelines, booklets, manuals, and reports were obtained from various university, state and federal sources. Contractor reports or publications were obtained from several recent or current research programs. The industrial contacts included the National Agricultural Chemicals Association, which had previously issued a series of pertinent manuals, and telephone contacts with about 100 pesticide manufacturers and formulators. Requests were made for technical data sheets, brochures or other available literature that contained information on product properties, handling, cleanup and stability, or on disposal of containers. Approximately 45 companies sent information of this nature. The total data base consisted of about 400 documents and papers, excluding the abstracts mentioned above.

Pesticide Classification System

Specific disposal methods have not, of course, been described for each of the 550 pesticides identified on this program as potential disposal candidates. In many cases, however, general procedures were found for the class of compounds of which a given compound is a member. Therefore, the pesticides were classified into groups according to chemical structural features. A pesticide classification system was then developed in order to aid in the identification of acceptable specific disposal techniques for each group. The priority system is set forth in Table 3, together with the number of pesticides in each category.

According to this system, all pesticides which contain highly toxic metals such as arsenic or mercury are in the first group classification, because such compounds cannot be completely detoxified by any means. A number of other inorganics are also included in this classification.

A pesticide which has two or more key elements or functional groups is generally assigned the highest applicable classification (see exceptions, next paragraph). Thus, a pesticide which contains chlorine, phosphorus, sulfur and carbon (e.g., coumaphos) is classified as a phosphorus compound because, of these four elements, phosphorus has the highest priority in the ranking system. The usefulness of a classification system of this kind is indicated by the fact that the decomposition chemistry of this particular pesticide (as well as its hazard to humans) will most likely depend primarily on the chemistry of the phosphorus-containing portion of the molecule.

In order to be of maximum usefulness, however, a system of this kind must be flexible: certain pesticides were thus assigned to classifications of less than the highest possible priority because they more closely resembled the compounds in a lower priority group. For example, certain pesticides which contained both chlorine and sulfur would, according to the system, be classified as "chlorine-containing pesticides," However, some of these were actually placed in the lower priority group, "sulfur-containing pesticides," because they more closely resembled the sulfur compounds in terms of their disposal chemistry and environmental hazard. Similarly, certain pesticides of the dithiocarbamate family contain such metals as iron, manganese or zinc, but because of toxicity considerations these were grouped with the other dithiocarbamates rather than with the heavy metals.

TABLE 3

PESTICIDE CLASSIFICATION SYSTEM

Pesticide Classification	Number of Pesticides
Inorganic and metallo-organic pesticides	
Mercury compounds	28
Arsenic compounds	17
Copper compounds	11
Other heavy metal compounds	6
Cyanides, phosphides, and related compounds	6
Other inorganic compounds	11
	79
Phosphorus-containing pesticides	
Phosphates and phosphonates	19
Phosphorothioates and phosphonothioates	34
Phosphorodithioates and phosphonodithioates	27
Phosphorus-nitrogen compounds	8
Other phosphorus compounds	5
	93
Nitrogen-containing pesticides	
N-alkyl carbamates, aryl esters	22
Other N-alkyl carbamates and related compounds	7
N-aryl carbamates	6
Thiocarbamates	10
Dithiocarbamates	13
Anilides	13
Imides and hydrazides	9
Amides	6
Ureas and uracils	20
Triazines	14
Amines, heterocyclic (without sulfur)	18
Amines, heterocyclic (sulfur-containing)	12
Nitro compounds	26
Quaternary ammonium compounds	6
Other nitrogen-containing compounds	19
	201

TABLE 3 (Concluded)

Pesticide Classification	Number of Pesticides
Halogen-containing pesticides	
DDT	1
DDT-relatives	8
Chlorophenoxy compounds	12
Aldrin-toxaphene group	16
Aliphatic and alicyclic chlorinated hydrocarbons	15
Aliphatic brominated hydrocarbons	5
Dihaloaromatic compounds	10
Highly halogenated aromatic compounds	19
Other chlorinated compounds	4
	90
Sulfur-containing pesticides	
Sulfides, sulfoxides and sulfones	6
Sulfites and xanthates	4
Sulfonic acids and derivatives	5
Thiocyanates	4
Other sulfur-containing pesticides	4
	23
Botanical and microbiological pesticides	19
Organic pesticides, not elsewhere classified	
Carbon compounds (< 9 carbon atoms)	18
Carbon compounds (> 9 carbon atoms)	23
Anticoagulants	4
	45
TOTAL	550

SECTION V

ASPECTS OF THE PESTICIDE DISPOSAL PROBLEM

An appreciation of the magnitude of the pesticide disposal problem requires some understanding of how pesticidal products are produced, packaged, sold to the consumer, and normally utilized. A broad definition of "pesticides" is used herein which includes: algicides, defoliants, desiccants, fumigants, fungicides, herbicides, insecticides, lampreycides, larvacides, miticides (acaricides), molluscicides, nematocides, plant growth regulators, repellents, rodenticides, sterilants, and synergists. For purposes of discussion, the pesticides are frequently grouped in the literature into the dominant categories of herbicides, insecticides and fungicides.

The government's basic regulatory authority for pesticides resides in the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) of 1947 and its amendments. Title 40 of the Code of Federal Regulations covers pesticides. The newest amendments to FIFRA, the Federal Insecticide, Fungicide and Rodenticide Act of 1972, (Public Law 92-516), include three sections which are pertinent to pesticides disposal problems as follows:

> Section 19 - Disposal and Transportation, (a) Procedures.--The Administrator of the Environmental Protection Agency shall establish procedures and regulations for the disposal or storage of packages and containers of pesticides and for the disposal or storage of excess amounts of such pesticides, and accept at convenient locations for safe disposal a pesticide the registration of which has been cancelled under Section 6 (c) if requested by the owner of the pesticide.
>
> Section 13 - Stop Sale, Use, Removal and Seizure, (c) Disposition after condemnation.--If the pesticide or device is condemned it shall, after entry of the decree, be disposed of by destruction or sale as the court may direct.
>
> Section 12 - Unlawful Acts, (a) (2) (G).--It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling.

Under this authority, the EPA has developed guidelines for the acceptance, storage and disposal of pesticides and pesticide containers. These regulations (40 CFR, Part 165) were published after the present report was nearly complete, but are included as Appendix A. As this chapter will indicate, many aspects of the pesticide disposal problem require additional research, and the EPA guidelines are expected to be updated from time to time as new information and new technologies become available.

Pesticide Production and Marketing Practices

The pesticide production, distribution, and marketing network is complex. This network begins with the basic chemical manufacturer who synthesizes or otherwise produces the "active ingredients" (a.i.), that is, the individual chemical having pesticidal properties. The manufacturer may produce a "technical" material (typically > 95% a.i.) which may be packaged and sold to either a dealer or the consumer. More often, however, the technical material is not suitable for direct use by the consumer, and must be converted to concentrations and physical forms suitable for specific uses and methods of application. This conversion process is called "formulating" the pesticide, and the products are called "formulations."

The number of pesticides actually produced and the number of producers vary from year to year as new pesticides are discovered and other pesticides are discontinued. During the past 3 years, nearly 100 U.S. companies engaged in the manufacture of about 275 individual pesticidal chemicals, and other pesticides were imported. The total United States production of synthetic pesticides is about 1.3 billion pounds per year (not including coal tars, creosotes, petroleum oils, aromatic and mineral solvents and dry carriers). In all, about 125 pesticides are each produced in quantities of over 1 million pounds per year.[13/] Major pesticide manufacturers are listed in Appendix B, estimated production volumes of major pesticides are listed in Appendix C, and the trade and brand names of selected pesticides are listed in Appendix D.

While the number of active ingredients in use is large, the number of formulated products on the market is far larger: about 8,000 different formulations are apparently available from over 1,800 formulators and distributors.[13/] Over 50,000 "labels" are said to have been registered by the U.S. Department of Agriculture: each company that markets a given formulation must have its own registered label. Over 3,500 companies appear to hold federal registrations for one or more products. Pesticide products may be registered for intrastate sale by a company: an estimated 2,000 products are thus registered in California alone.

The pesticide is formulated by adding to the a.i. one or more of a host of other ingredients. The manufacturer may formulate at the a.i. production site, or at one or more other locations, in either his own facilities or in those of a contract formulator. The manufacturer then sells the products under his registered labels, which contain a list of ingredients and instructions for handling and application. Alternatively, the a.i. manufacturer may sell the technical material (or a concentrate of it) to an independent formulator who, in turn, may formulate the pesticide into one or more products to suit the needs of his customers and sell the products under his own registered labels.

Many manufacturers and formulators may also package material under the registered label of one of their customers, and some do not market directly to the consumer at all. An independent packager may also buy technical or formulated pesticides, repackage them, and sell the products under his own registered labels. The marketing of pesticide products encompasses a large segment of commerce: marketing outlets include dealers and distributors, farm co-ops and other associations (e.g., of structural applicators) home and garden suppliers, hardware stores, etc.

Three major reasons account for the large number of formulations:

* A given pesticide (such as DDT) may be physically formulated in many forms: emulsifiable concentrate (e.c.); wettable powder (w.p.); dust; or granules (gr.). The formulations selected depends on specific intended applications.

* A given pesticide may be formulated at different concentrations in the same physical form in order to meet different use requirements. The concentration of active ingredient may vary by more than one order of magnitude. Solvents, surfactants, synergists, and other additives may vary from one formulator to the next.

* A given pesticide may be formulated in a mixture with one or more other pesticides. Over 500 commercially available formulations contain more than one active ingredient. A formulation may contain two to five pesticidal chemicals. These mixtures are marketed to meet specific use requirements. A tabulation of commercially available mixtures is given in Appendix E.

Pesticides (active ingredients and formulations) are transported in containers as large as 8,000-gal. tank cars, but are most often sold to the consumer in drums (5, 30 or 55 gal.), cardboard cartons and paper bags (0.5 to 50 lb), and other small containers (glass or plastic bottles or metal cans, usually holding 1 gal. or less).13/ The agricultural market is estimated to require about 100 million pesticide containers, the "average container" holding about 8 lb of material having 50% active ingredient. The home and garden market has been estimated to require 100 million aerosol containers and 200-400 million nonpressurized containers for pesticides. Other sectors of the pesticide market (such as the professional structural applicator, industrial user, and various governmental agency users) require additional millions of containers.

The disposal of unused or spilled pesticides and of empty pesticide containers poses, then, an extensive problem. The description of specific disposal procedures for all the available products would be a prohibitively large task. Disposal guidelines are obviously needed.

Previous Disposal Studies and Recommendations

The safe use and proper handling of hazardous chemicals have long been sought by industry and the government. In recent years, the proper disposal of pesticides, pesticidal wastes and pesticide containers have been of increasing interest to the chemical and pesticide industry,[14-20] to numerous state and local agencies or universities,[21-29] to agencies of the federal government[30-43] their contractors, and grantees,[13,44-50] and to many other groups.[51-68]

This sizable volume of literature[13-68] has served as a starting point for this program. Most previous work, however, has focused on either the problems of disposal of relatively large amounts of industrially generated pesticidal wastes, on very small amounts of pesticides appropriate to preliminary laboratory studies, or on the ubiquitous problem of "empty" containers.

The pesticide manufacturers and formulators have utilized a variety of methods for the handling, treatment, and disposal of pesticide-containing wastes. While many of their methods are not suitable for direct adaptation for use by the layman, a brief description of some of the main features of the operation, capabilities and limitations of these methods is given below. The methods are classified according to the three general purposes they serve:

* In-house control of waste streams primarily involves either economy of production (e.g., the use of recycle streams or better product recovery), good occupational safety practice, or minimization of the waste disposal or treatment burden.

* Direct and final disposal consists essentially of methods such as ocean disposal, deep-well injection, burial, and dilution/discharge into water or air. The latter method is becoming less useful because of stringent new regulations. Burial in an open pit or landfill is becoming increasingly regulated because of leaching or subsurface movement of the pesticide and subsequent contamination of surface or groundwaters (leaching occurs in sandy soils more readily than in clays or in highly organic soils).

* Treatment methods to remove the pesticide from the waste stream prior to its discharge have a number of variations which require elaboration: the treatment may involve a combination of physical, chemical, biological or thermal methods.

. Physical methods include: mechanical collectors (cyclone); filters (baghouses) and wet scrubbers for air streams; adsorption, coagulation/precipitation (a chemical additive may be used as an aid), liquid-liquid extraction, and foam fractionation for liquid streams. An evaporation pond (no discharge) combines physical and biological methods.

- Chemical methods include: pH adjustment, which may be neutralization, acidification or alkalinization (usually using acids, caustics or most often lime); oxidation, using oxygen (usually air), chlorine or sodium hypochlorite, ozone, etc., and photochemical methods (sunlight or ultraviolet radiation).

- Biological methods involve degradation of the pesticides by microbiological cultures either under: (a)aerobic conditions, e.g., in stabilization ponds, aerated lagoons, trickling filters (followed by a settling tank), and activated sludge; or (b) under anaerobic conditions, i.e., without the presence of air. These methods have drawbacks in that: degradation is usually slow; the system must be carefully protected in regard to pH, shock overloads and nutrient levels; the efficiency of degradation varies with the physical form of the pollutant (e.g., a pesticide adsorbed on particles may not be as susceptible to degradation as it would be if it was in solution) and the chemical structure of the pollutant (e.g., chlorophenols are not efficiently degraded by cultures which break down many organics, but may be degraded by special cultures).

- Thermal methods involve decomposition and chemical degradation of the pesticides at elevated temperatures. Pyrolysis, the thermal "cracking" of the molecular structure in the absence of air, is possible for almost every pesticide, but has been seldom used for practical reasons. Combustion and incineration methods are preferred, the former usually implying burning of the pesticide either alone or in a solvent in air, and the latter usually implying burning of the pesticide in special equipment which may be gas-fired and have a forced-air draft to maintain high, uniform operating temperatures. The burning may be conducted in a furnace or in a trench. Precautions are required to prevent smoke emission, and special precautions are required for pesticides which cannot be completely detoxified, e.g., those containing heavy metals (such as mercury or arsenic), boron, or fluoride, or those which form corrosive gaseous products such as HCl, NO_x and SO_2. A water or caustic scrubber is frequently necessary.

The pesticide waste-disposal method or treatment method which is selected by a manufacturer or formulator depends on several factors such as: the amount of material he has to dispose of; the local regulations and permissible discharge levels; the form and concentration of the hazardous material; and the cost of treatment or disposal facilities. Many of these factors are in turn dependent on the chemical, toxicological and environmental properties of the pesticides. These properties are frequently similar for different pesticides of the same general chemical class, or of a structure having a common dominant functional group. Special attention has been called to certain of these classes, such as:

* The inorganic and metallo-organics. These pesticides contain mercury, arsenic, thallium, boron, fluoride, etc., and cannot be made completely nontoxic.

* The phosphorus-containing pesticides. These pesticides are nearly all insecticides and most are of the cholinesterase-inhibiting type. Their toxicities, however, range from very high[a] (oral $LD_{50} \simeq 5$ mg/kg for parathion) to fairly low ($LD_{50} \simeq 2800$ for malathion and ~ 5000 for Gardona®). Most of these compounds are susceptible to hydrolysis (usually under alkaline conditions) and are not persistent in the environment.

* The carbamates. This class has a very broad range of biological activity. The N-alkyl carbamates are cholinesterase-inhibiting insecticides, like the organophosphates, and most are very toxic. The N-aryl carbamates are herbicides and are, in general, much less toxic than the N-alkyl carbamates. A series of thiocarbamate herbicides and dithiocarbamate fungicides is known (many of the latter are metal salts). The carbamates are generally "nonpersistent" and are subject to caustic degradation. The dithiocarbamates are subject to acid hydrolysis.

* The chlorinated hydrocarbons. This class of compounds, by conventional usage, does not contain all the chlorinated pesticides, but normally refers to the series of insecticides which is rather highly chlorinated, including DDT, lindane, chlordane, aldrin, and toxaphene, most of which are fairly or quite persistent in the environment. Most members of this class pose a difficult disposal problem and can be effectively degraded best by incineration methods.

* The phenoxys. The phenoxyalkanoic acid herbicides such as 2,4-D and 2,4,5-T have a low environmental persistence, although they are chlorinated compounds. They are generally susceptible to alkaline hydrolysis or incineration methods.

* The botanicals. Pesticides such as rotenone and pyrethrins are usually insecticides which have relatively low toxicity to man but high toxicity to fish. They are usually susceptible to degradation in normal organic waste treatment facilities or by combustion and breakdown in the environment.

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[a] The most commonly used measure of acute toxicity is the LD_{50}, i.e., the dose of the substance which kills half of the experimental animals by any test. Oral LD_{50}'s (in units mg/kg of body weight) are most often reported. The lower the LD_{50}, the more toxic the substance.

* Other classes. The many remaining classes and subclasses have been the subject of less discussion than the preceding classes, and will be described further in Section VII.

The results of the laboratory-scale studies of pesticide disposal are discussed in Section VII in connection with specific pesticides. In general, disposal methods which have been found effective on the laboratory-scale have not been demonstrated on a larger (nonindustrial) scale. Very little consideration has been given to the practical problems associated with the disposal of small quantities of pesticides by the layman.

Finally, the many instructions and discussions concerning pesticide container disposal center on two major problems caused by inability to empty the pesticidal contents completely. One of these is that abandoned containers pose a serious hazard to children and animals (as well as unnecessary environmental pollution). The solution: rinse, crush and bury or burn the containers. The second major problem is reuse of the contaminated empty container for other purposes, which again poses hazards to man and the environment. The solution: send the drums to a commercial reconditioner. Inherent in the container problem are other problems, i.e., those of collection, storage and decontamination, all of which have received considerable study.

The Problem of Mixed Pesticides

Pesticides are used both as formulations containing only a single active ingredient and as formulations containing two, three or more different active ingredients to make them more effective against a variety of pests. Data are not available on the relative amounts of all pesticides that are used as single active ingredient formulations and as "mixed" formulations, but the proportion of the latter is significant (and may be nearly 50% of the total in the home, lawn and garden market).

Information is available, however, on the number and types of mixtures that are marketed commercially: over 500 mixtures that contain two or more active ingredients each have been noted in the Pesticide Handbook - Entoma.[12/] The two or more ingredients may be mixed in the same proportions by several different companies (and thus sold under different trade names) or the same ingredients may be mixed in different proportions in different products by the same or different manufacturers. Furthermore, the concentrations of ingredients may be stated in different units on different products. For example, 16 products that contain toxaphene, DDT and methyl parathion are noted. The listed combinations are given for liquids in either pounds per gallon or percentage as shown below:

Toxaphene	DDT	Methyl Parathion
4 lb/gal	2 lb/gal	0.5 lb/gal
4 lb/gal	2 lb/gal	0.75 lb/gal
4 lb/gal	2 lb/gal	1 lb/gal
49.28%	22.40%	3.36%
37.9%	18.9%	9.4%

The ingredients of a given type of mixture are in roughly the same relative proportions in different products (as in the example above) in most combinations, but in some cases the proportions are varied considerably for different intended applications. The example below illustrates the range of compositions which could be encountered:

Carbon Tetrachloride (%)	Ethylene Dichloride (%)	Ethylene Dibromide (%)
64	29	7
32	9	59

The mixtures that are marketed may contain components that are: (a) chemically, toxicologically and environmentally similar to each other, e.g., 2,4-D and 2,4,5-T or, BHC, chlordane and DDT; or (b) quite dissimilar, e.g., parathion and DDD; captan, DDT, dinocap and malathion; or ferbam, malathion, methoxychlor, phenothiazine and sulfur. In addition, the components or their concentrations may be changed from time to time by the manufacturer without any change in the trade name of the product (although a new active ingredient concentration would appear on the label).

The previous laboratory investigations of pesticide degradation or disposal have been restricted almost entirely to the study of one active ingredient at a time, since more complex mixtures would complicate the procedures or might produce ambiguous results. Hence little or no experimental information is available on the most effective or safest method of disposing of mixtures. Because of the wide number and variability of mixtures that are available, disposal must be considered on almost a case-by-case basis.

Environmental Criteria for Disposal Methods

An acceptable pesticide-disposal procedure should not pose a danger to environmental quality. A potential disposal method should be evaluated from several important environmental viewpoints. It should:

* Minimize the potential for damage to water quality. Criteria for permissible levels in public water supplies have been established for several pesticides and related chemical species, but not for most pesticides. Since these are all biologically active compounds to some degree, their levels in water whould be minimized.

* Make minimal contribution to problems of air pollution and solid waste disposal. Some pesticides degrade rapidly in the atmosphere, but a number have been detected as atmospheric pollutants, and some are quite persistent. In addition, procedures which generate smoke, dusts or fumes are undesirable, particularly when these contain the pesticides themselves. Procedures that contribute to litter of the environment are obviously undesirable, but methods which require solid waste disposal may be permissible, depending on circumstances.

* Degrade the pesticide. Ideally, a disposal procedure would convert the pesticide into a biologically inactive form, but this ideal is difficult, if not impossible, to attain. Alternatively, an acceptable disposal procedure should convert the pesticide into a less hazardous form: a persistent material rendered nonpersistent; a biomagnified one rendered nonaccumulative; a toxic material rendered less toxic to man, animals, fish, wildlife, or vegetation; a high concentration of a synthesized chemical changed to low concentrations of chemical forms already found in nature.

Data related to some of these environmental considerations are given in Section VI.

Practical Considerations of Methods for the Layman

An acceptable pesticide disposal procedure, in view of the primary objectives of this program, must be one which can be used by the layman. Several limitations and restrictions should be recognized:

* The layman has limited equipment. He does not have high-efficiency incinerators, reaction flasks, ozonators, pressure equipment, or other laboratory equipment.

* He has a limited number of chemicals available. Hardware stores or soil and garden centers are convenient, but a chemical supply house usually is not.

* He has limited experience. While he may have experience in using pesticides according to label directions, he has little experience in performing chemical reactions, in incineration or even in repackaging pesticides for collection.

* He should not be exposed to a greater personal hazard in disposing of the pesticide than in using it according to the directions on the label.

A number of practical considerations should be made before deciding on a disposal procedure, such as:

* The total amount of material to be disposed of--1 qt, or 55 gal. (a full drum). If it is the latter, the layman should call a professional.

* The human hazard--the number of potentially lethal doses involved. Is the quantity of active ingredient capable of killing 1,000 adults if each swallowed a portion (e.g., 60 lb DDT or 1 lb parathion), or is there not enough to cause a serious illness to one,? (e.g., 1 lb of the insecticide Dimethrin, LD_{50} = 40,000 mg/kg) (see Section VI). In the case of the former, a professional's help should be sought, particularly if the amount is greater than 10 lb.

* The types of formulation, the percentage of active ingredient and the nature of the diluent or carrier. An oil solution of a pesticide would be difficult to mix with an aqueous detoxification solution; a clay-based material would be difficult to burn.

* The time factors. The disposal should be effected completely in a short time so that no containers of improperly labeled pesticide mixture are left standing around as an accident hazard.

* The nature of any chemical degradation reactions. Reactions should be quick, one-step procedures which do not require heating or excess stirring, and should not give unexpected hazardous volatile products or unusually toxic reaction intermediates.

* The potential harmful effects on the immediate environment. Examples would be the deactivation of a biological sewage treatment system or the destruction of nearby vegetation.

* Proven efficiency and safety. Any method considered for recommendation should have been demonstrated on a sizable scale, e.g., 50 lb or at least 5 lb.

* The disposal chemicals. The quantity needed cannot be prohibitively large or its cost too great, in any instance, or the method will probably not be employed by the layman.

Limitations in the Available Data

A general review and evaluation of the literature indicated serious information gaps, and identified several practical problems which, in total, preclude the confident prescription of completely acceptable procedures which the layman could use for each one of the 550 pesticides. Some examples include:

* Previously recommended methods: Disposal methods which have been previously recommended for pesticides are often no longer acceptable because of changing standards, e.g., environmental restrictions. Others are not acceptable for our purposes because of the limitations inherent in the layman's equipment, available chemicals, or experience.

* The "dilemma" pesticides: Certain pesticides cannot be completely detoxified. Degradation of pesticides which contain heavy metals such as mercury, arsenic, thallium, etc., or certain inorganic elements such as fluorine, always leaves a toxic residue which must be disposed of. A useful rule of thumb is that ground burial is permissible when small amounts of material (particularly when they are in a form already found in nature) are involved.

* Demonstrated methods: Acceptable disposal methods have been successfully demonstrated on an industrial scale for a number of pesticides and on a laboratory scale for a number of the same or other pesticides. The efficiency and safety of most potential or proposed chemical disposal procedures have generally not been demonstrated, however, on a scale (1 to 50 lb) and in equipment most likely to be of use to a layman. In addition, literature reports of degradation/detoxification reactions are often based on results of laboratory studies under idealized conditions, e.g., the ratio of reagent to pesticide may be 100:1 or even 1,000:1. None of the literature methods have discussed the possible effects of other ingredients such as emulsifying agents and surfactants.

Biological degradation methods are not sufficiently developed or have not been demonstrated to be suitable for rapid, efficient reaction of sizable amounts of pesticides to be confidently recommended.

* Toxicity and pollution characteristics of the degradation products: In some instances, a degradation reaction either gives reaction intermediates or final products which are more toxic to mammals than is the original pesticide. An example is the alkaline hydrolysis of trichlorfon, an

organophosphate insecticide, which produces the more toxic dichlorvos as a reaction intermediate during degradation, with the effect shown in Figure 1 under one set of reaction conditions (N.B. under practical conditions of disposal, the entire reaction may proceed rapidly). In other instances, a potential degradation procedure may give a product which is more hazardous than is the original pesticide, e.g., 2,4,5-trichlorophenol (LD_{50} of 150 to 250 mg/kg) is formed by hydrolysis of ronnel (LD_{50} of 1,700 mg/kg). The lethal oral dose for a normal man would thus be decreased from nearly a pint to less than 1 oz.

Such reactions should never be carried out in a "bucket," but a method involving burial in the ground with lime might be recommended.

* Uncharacterized degradation products: In many cases, the products of the degradation reaction are either unknown or of uncertain toxicity or environmental impact. In either instance, recommendation of such a disposal method has obvious drawbacks. The environmental restriction also applies to any degradation products of unknown environmental hazard, e.g., a chlorinated insecticide might be degraded to an insecticidally inactive, chlorinated hydrocarbon, but the latter might be persistent, biomagnified, and hazardous to certain species of wildlife.

* Unknown rate and heat of reaction: Many degradation reactions which have been mentioned in the literature are not accompanied by information on the rate and heat of reaction, e.g., the reaction mixture may have been refluxed 2 hr or let stand overnight on a steam bath. In order to recommend a detailed decontamination method, one must know approximately the reaction rate at ambient temperature (a few minutes, 1 day, or 1 month?) and whether the reaction mixture might heat up dangerously (even explosively) upon scale-up. Methods which involve slow chemical reactions should not be recommended unless the mixture can be buried: a "bucket" or improperly labeled container of adulterated pesticide might pose serious hazards. Methods which involve heating a reaction mixture to speed the reaction should be excluded if danger exists of volatilizing toxic or hazardous (even herbicidal) ingredients. For example, one of the extremely toxic phosphates, parathion, can explode when heated strongly, especially when certain catalytic impurities are present.

In summary, the literature contains few results based on systematic research on chemical degradation of pesticides. Most publications on pesticides are concerned with synthesis, effects, analysis of metabolic activity, etc. The few studies that have dealt with chemical degradation of pesticides have rarely used methods suitable for use by a layman. (One suspects that many unexpected degradation reactions have been observed, but chemists are not inclined to elucidate and publish such reactions.) All too often,

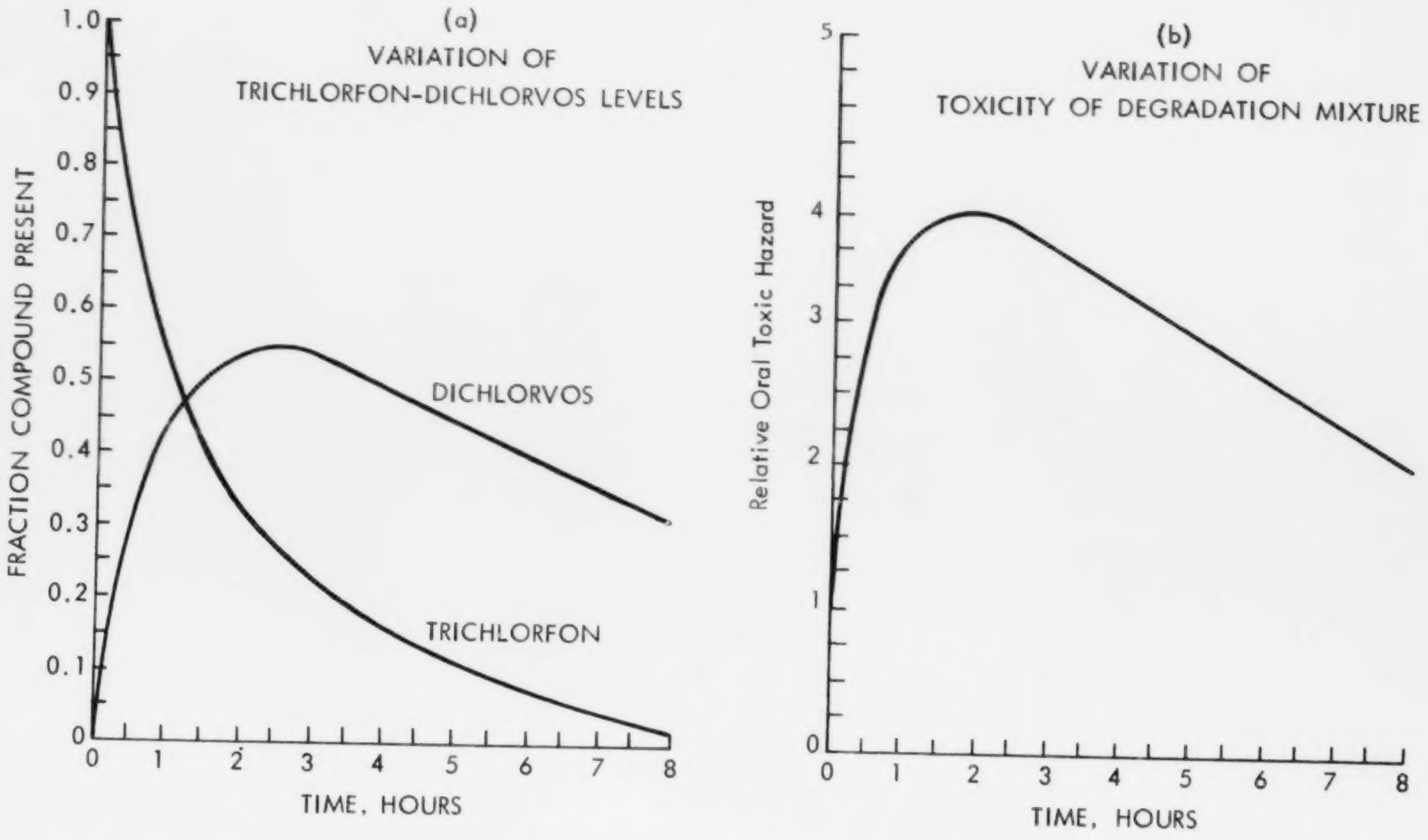

Figure 1 - Toxic Hazard During Degradation of Trichlorfon (at pH 8.0).66/

simple procedures such as hypochlorite oxidation, which might well be effective, have apparently not been reported, and therefore, cannot be confidently recommended.

In evaluating the information on potential disposal procedures, one must conclude that if one rigorously excluded all use of ground burial, dumping, dilution/discharge, incineration, and "apply as directed" methods for substances or mixtures which have some environmental hazard, the layman would hardly be able to dispose of a single pesticide by himself. On the other hand, although each of these methods has certain environmental drawbacks, numerous compromises are possible which are useful, will minimize the environmental damage, and are not overly objectionable. For example, proper ground burial of a heavy-metal pesticide would be much superior to dilution/discharge or incineration. In other cases, burning might be preferable to dilution or burial. On the other hand, the toxicity and apparent environmental hazard of some pesticides are so low (say an LD_{50} greater than that of salt) that detoxification does not seem necessary, i.e., dilution or dumping will suffice for disposal of the small amounts which the average layman has.

SECTION VI

TOXICITY AND ENVIRONMENTAL PERSISTENCE DATA FOR SELECTED PESTICIDES

The toxicity and environmental persistence of a pesticide are important considerations in evaluating disposal methods. The data summarized in this section were collected from many sources, and include trade names; the reader may need to refer to the cross-index of pesticide names in Part II to determine the common names as used in other portions of this report.

Toxicity to Humans

"Toxicity" is a rather general term used in discussing the poisonous character of a substance; in a more specific discussion, the exact test method and the nature of the toxic action must be defined. Thus, the test subjects are usually fish, fowl or small laboratory animals, and almost never humans. The test approach may be either to determine the size of the single dose which will kill or sicken the subject (acute toxicity) or the dose, which over a period of time, kills or sickens the subject (chronic toxicity); or to determine whether the substance has carcinogenic (causes cancer), teratogenic (causes birth deformities) or mutagenic (causes genetic mutations) effects. The test substance may be given to the subject orally, dermally (on the skin), or by injection or implantation of a pellet (either under the skin or interperitoneally).

The most widely used test is to determine the acute oral toxicity: the results are reported in terms of the LD_{50}, i.e., the quantity of substance given to the subjects (in units of mg/kg of body weight) which kills one half of the test animals. Unfortunately, the LD_{50} is not a precise, reproducible number: the value determined often varies with the species, strain and the sex of the test animals, and between laboratories. In addition, the oral LD_{50}'s are usually lower than dermal LD_{50}'s, but higher than intraperitoneal LD_{50}'s (a low LD_{50} indicates a high toxicity). For inhalation toxicity or for tests on fish, the results are usually expressed in terms of air or aqueous concentration of the substance, either as a LC_{50}, or some tolerance limit. Other approximate measures of toxicity are sometimes used but the LD_{50} is most often used for a quick comparison of the toxicity of a substance to that of another substance. The LD_{50}'s of pesticides are widely reported,1,5,6,8,11,69-72/ but two or more differing results are frequently available for a given pesticide.

Figure 2 illustrates the relationship between the oral LD50, the probable[a] lethal dose for a 150-lb man (given in both units of milliliters and familiar units such as drops or ounces) and the relative descriptions (e.g., moderately toxic) used by three authoritative sources (Deichman and Gerarde's book on toxicology;[73] the railroads;[74] and the USDA[75]) to classify toxicity of hazardous substances. It also shows the location on the scale of several familiar examples. The four LD_{50} categories[75] used by the USDA's former Pesticide Regulation Division, Agricultural Research Service have been used, together with dermal LD_{50}'s and the inhalation LC_{50}'s, as guides in the regulation of pesticide registration and labeling. These are generally the terms actually required on the container label itself. In a 1967 publication intended for use by farm advisors, etc., the USDA interpreted the four toxicity categories as follows:

- Very high applies to products in Registration Category I, whose labels are required to bear a skull-and-crossbones and the words, "Danger--Poison."

- High applies to products in Category II, whose labels are required to bear the work "Warning," and a warning statement.

- Medium applies to products in Category III, whose labels are required to bear the word "Caution," and a caution statement.

- Low applies to products in Categories III or IV whose labels may or may not be required to carry a caution statement.

Another quick indication of the relative toxicities of several pesticides is supplied by the criteria which have been established[71] for pesticide levels in public water supplies, as shown in Table 4. The mammalian oral and dermal LD_{50}'s of a large number of pesticides are given in Table 5. Most of these are from one reasonably authoritative source,[69] but many different values may be found in the literature, and additional data have been summarized[70a-70c] and recent results[70c] may, in some instances, be significantly different than those reported here. (The compilation of "best values" awaits the further efforts of toxicology experts.)

Acute inhalation toxicity data are less readily available than oral toxicity data. However, the American Conference of Governmental Industrial Hygienists has established threshold limit values[76a] for occupational exposure to over 70 pesticides, as listed in Table 6.

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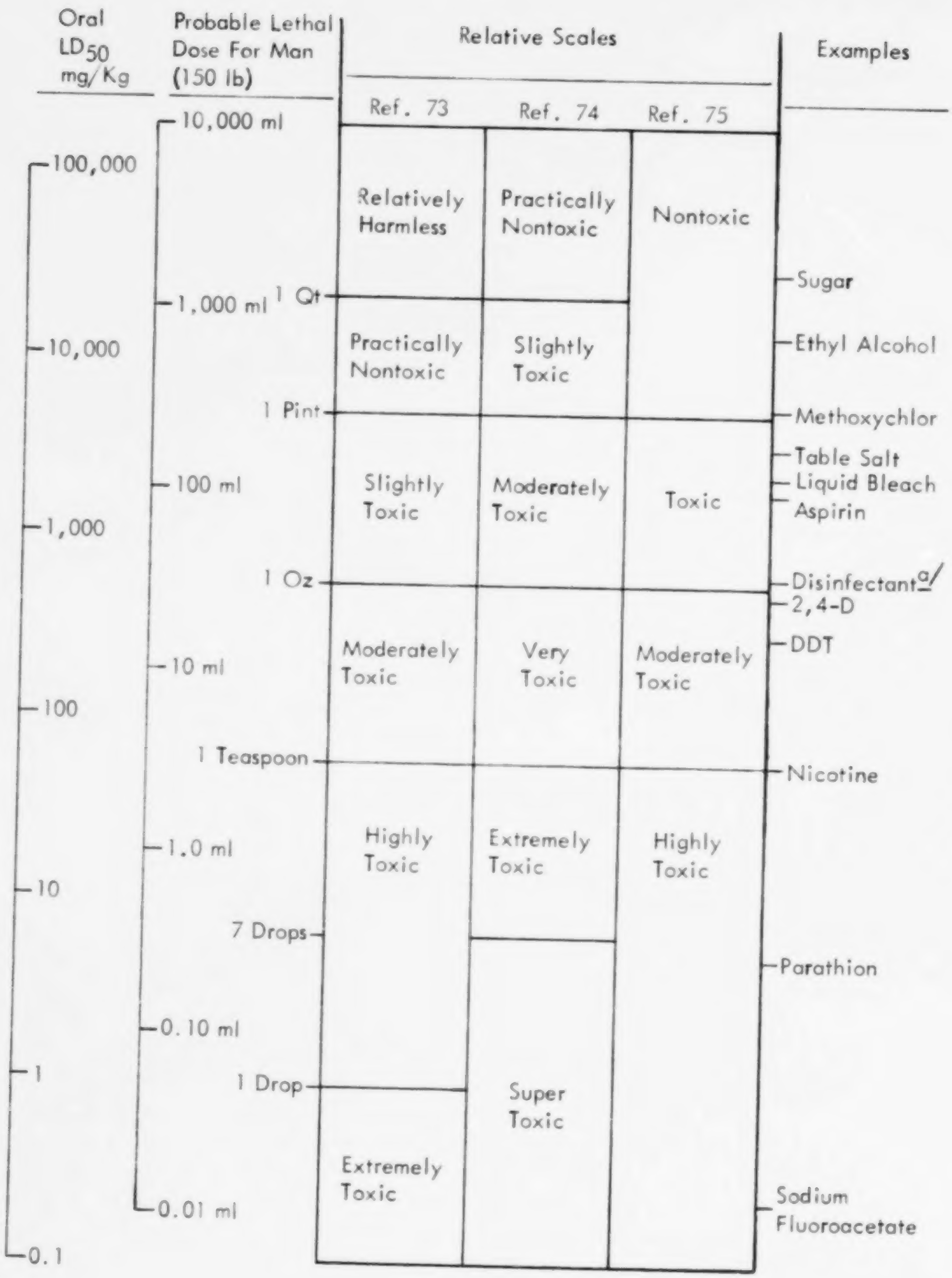
[a] For sensitive individuals, the lethal dose could be far less than those listed.


Oral LD$_{50}$ mg/Kg
Probable Lethal Dose For Man (150 lb)
Relative Scales
Examples
Ref. 73
Ref. 74
Ref. 75
100,000
10,000
1,000
100
10
1
0.1
10,000 ml
1,000 ml
1 Qt
1 Pint
100 ml
1 Oz
10 ml
1 Teaspoon
1.0 ml
7 Drops
0.10 ml
1 Drop
0.01 ml
Relatively Harmless
Practically Nontoxic
Slightly Toxic
Moderately Toxic
Highly Toxic
Extremely Toxic
Practically Nontoxic
Slightly Toxic
Moderately Toxic
Very Toxic
Extremely Toxic
Super Toxic
Nontoxic
Toxic
Moderately Toxic
Highly Toxic
Sugar
Ethyl Alcohol
Methoxychlor
Table Salt
Liquid Bleach
Aspirin
Disinfectant[a]
2,4-D
DDT
Nicotine
Parathion
Sodium Fluoroacetate

[a] Alkylaryl quaternary ammonium compound.

Figure 2 - Relative Toxicity Scales

TABLE 4

CRITERIA FOR PESTICIDES IN PUBLIC WATER SUPPLIES[71]

Chemical	Type[a]	Permissible Criteria ppm or mg/ℓ
Phenols	Organic[b]	0.001
Endrin	CH-CP	0.001
Chlordane	CH-CP	0.003
Toxaphene	CH	0.005
Aldrin	CH-CP	0.017
Dieldrin	CH-CP	0.017
Heptachlor	CH-CP	0.018
H. epoxide	CH-CP	0.018
Methoxychlor	CH-D	0.035
DDT	CH-D	0.042
Arsenic	I	0.05
Lindane	CH	0.056
Organic phosphates and carbamates	Chol.	0.1 total, as parathion equivalent
2,4-D, 2,4,5-T and 2,4,5-TP	Herbicide	0.1 total
Cyanide	Organic	0.20
Ammonia	I[b]	0.5 (as nitrogen)
Boron	I	1.0
Copper	I	1.0
Zinc	I	5.0
Nitrates and Nitrites	I[b]	10.0 total

---

[a] Abbreviations: CH, chlorinated hydrocarbons; CP, hexachlorocyclopentadiene family; D, DDT family; I, inorganic; Chol., cholinesterase inhibitor.

[b] Nonpesticidal chemical added for reference. These species may be degradation products of some pesticides.

TABLE 5

MAMMALIAN TOXICITIES OF PESTICIDES[1,69]

I Herbicides and growth regulants

	Oral LD$_{50}$ [a] mg/kg	Dermal LD$_{50}$ [a] mg/kg
Acrolein	42-46	562 Rb
Allidochlor (CDAA, Randox®)	700	360
Ametryne (Gesapax®)	1110-2980	
Amiben (Chloramben®)	3500-5620	3136 Rb
Aminotriazole (Amitrole®)	1100-2500	>10,000
Ammonium sulphamate (Ammate®)	3900-4400	
Arsenites, Na/K	70	150
Asulam	>5000	
Atratone	1465-2400	
Atrazine (Gesaprim®)	2000	
Avadex® (Di-allate)	393-1000	2000-2500 Rb
Avadex BW® (Tri-allate)	800-1810	
Azak® (Terbutol)	>34,600	>10,250
Balan® (Benefin, Quilan®)	>10,000	
Banvel-D® (Dicamba)	1100	>1000
Banvel-T® (Tricamba)	300-450	>1000
Barban (Carbyne®)	600	>1600
Benazolin	>3000	
Benefin (Balan®, Quilan®)	>10,000	
Bensulide (Betasan®)	770-1910	2000->9400 Rb
Benzthiazuron (Gatnon®)	1280	>500
Betanal® (Phenmedipham)	>2000	>500
Betasan® (Bensulide)	770-1910	2000->9400 Rb
BIPC (Chlorbufam)	2500	
Borates	2000-5330	
Bromacil (Hyvar-X®)	5200	
Bromoxynil	190-260	
Cacodylic acid	1350-3200	
Carbyne® (Barban)	600	>1600
Casoron® (Dichlobenil)	2700-6000	1350 Rb
CDAA (Allidochlor, Randox®)	700	360
CDEC (Sulfallate, Vegadex®)	850	
Chlorthal-methyl (DCPA, Dacthal®)	>3000	>10,000 Rb
Chloramben (Amiben)	3500-5620	3136 Rb
Chloranocryl (Dicryl, DCM)	3160	>3160 Rb
Chlorates, Na/K	1200-7000	
Chlorazine	1950	
Chlorbromuron	4287	
Chlorbufam (BIPC)	2500	
Chlorfenac (Fenac®)	1780-3000	>1360 Rb
Chlormequat chloride (ccc)	670	232-440 Rb
Chloroxuron (Tenoran®)	3700	>10,000 Rb
Chlorpropham (CIPC, Chloro-IPC)	3800-8000	
Chlorthiamid (Prefix®)	757	1000
CIPC (Chlorpropham, Chloro-IPC)	3800-8000	
CMPP (Mecoprop, Isocornox®)	700-1500	
CMU (Monuron)	3600-3700	>2500 Rb
Clobber® (Cypromid)	215-900	3038 Rb
Cotoran® (Fluometuron)	8900	>10,000 Rb
Cycluron (OMU)	1500-2600	
Cypromid (Clobber®)	215-900	3038 Rb
2,4-D	400-500	1500
Dacthal® (Chlorthal-methyl, DCPA)	>3000	>10,000 Rb
Dalapon-Na	4000-9300	
Daxtron® (Pyriclor)	80-130	>2000
Dazomet (DMTT®, Mylone®)	320-1000	>1000 Rb
2,4-DB	700	800
DCM (Chloranocryl, Dicryl)	3160	>3160 Rb
DCPA (Chorthal-methyl, Dacthal®)	>3000	>10,000 Rb
DCU (Dichloral urea)	6800	
DEF	325	
2,4-DEP	850	
2,4-DES-Na (Sesone, Disul)	700-1400	
Desmetryne (Semeron®)	1630-2375	>1000
Di-allate (Avadex®)	393-1000	2000-2500 Rb
Dicamba (Banvel-D®)	1100	>1000
Dichlobenil (Casoron®)	2700-6000	1350 Rb
Dichlone (Phygon®)	1300-2250	
Dichloral urea (DCU)	6800	
Dichlorprop (2,4-DP)	800	1400
Dicryl (Chloranocryl, DCM)	3160	3160 Rb
Dimexan	240-340	
Dinitrocresol (DNOC)	25-40	200-600
Dinoseb (DNBP)	50	80-200
Dinoterb-acetate	62	
Diphenamid	700-1050	>2000 Rb
Diphenatrile	3500	
Diquat dibromide (Reglone®)	400-440	>500 Rb

TABLE 5 (Continued)

	Oral LD_{50} a/ mg/kg	Dermal LD_{50} a/ mg/kg
Disul (2,4-DES-Na, Sesone)	700-1400	
Diuron (Karmex®)	3400-3700	
DMPA (Zytron®)	270	
(DMTT®, Dazomet, Mylone®)	320-1000	>1000 Rb
DNBP (Dinoseb)	50	80-200
DNOC (Dinitrocresol)	25-40	200-600
2,4-DP (Dichlorprop)	800	1400
DSMA	1800-2800	
Endothal	80	750
EPTC (Eptam®)	1600-3160	1460-10,000 Rb
Erbon	1120	
EXD (Herbisan®)	603	
Fenac® (Chlorfenac)	1780-3000	>3160 Rb
Fenoprop (Silvex®, 2,4,5-TP)	650-1070	
Fenuron	6400-7500	
Fluometuron (Cotoran®)	8900	>10,000 Rb
G 36393 (Methoprotryne, Gesaran®)	>5000	>150
Gatnon® (Benzthiazuron)	1280	>500
Gesagard® (Prometryne)	2500	>1000
Gesapax® (Ametryne)	1100-2980	
Gesaprim® (Atrazine)	2000	
Gesaram® (Methoprotryne, G 36393)	>5000	>150
Gesatop® (Simazire)	5000	
Glytac®	7000	
Gramoxone® (Paraquat dicloride)	112-200	236-500 Rb
Herban® (Noruron, Norea)	1476-4000	
Herbisan® (EXD)	603	
Hydram® (Molinate, Ordram®)	501-720	>2000 Rb
Hyvar® (Isocil)	3400	
Hyvar-X® (Bromacil)	5200	
Ioxynil	100-305	
IPC (Propham)	1000-9000	
Isocil (Hyvar®)	3400	
Isocornox® (Mecoprop, CMPP)	700-1500	
Karmex® (Diuron)	3400-3700	
Lenacil (Venzar®)	>11,000	
Linuron	1500-4000	
Maleic hydrazide	3800-6800	>4000 Rb
MCPA	800	>1000
MCPB	680	1000
Mecoprop (CMPP, Isocornox®)	700-1500	
Medinoterb-acetate	42	
Merphos	1270	
Metabromuron (Patoran®)	2000-3000	>10,200 Rb
Metham-Na (Vapam®)	820	800 Rb
Methiuron (Thiuron)	2200	
Methoprotryne (G 36393, Gesaran®)	>5000	>150
Molinate (Hydram®, Ordram®)	501-720	>2000 Rb
Monalide	>4000	
Monochloracetates	300-400	
Monolinuron	1800-2250	
Monuron (CMU)	3600-3700	>2500 Rb
Morfamquat Dichloride (PP 745®)	368-800	
Mylone® (Dazomet, DMTT®)	320-1000	>1000 Rb
Naptalam (NPA)	1770-8500	
Neburon	>11,000	
Nitralin	>2000	
Nitrofen	3050	
Norea (Noruron, Herban®)	1476-4000	
Noruron (Norea, Herban®)	1476-4000	
NPA (Naptalam)	1770-8500	
OMU (Cycluron)	1500-2600	
Ordram® (Molinate, Hydram®)	501-720	>2000 Rb
Paraquat dicloride (Gramoxone®)	112-200	236-500 Rb
Patoran® (Metabromuron)	2000-3000	>10,200 Rb
PCP (Pentachlorphenol)	280	105-350
Pebulate (PEBC, Tillam®)	1020-1120	>3000 Rb
Pentachlorphenol (PCP)	280	105-350
Pentanochlor (Solan)	10,000	>10,000 Rb
Phenmedipham (Betanal®)	>2000	>500
Phygon® (Dichlone)	1300-2250	
Picloram (Tordon®)	8200	>4000 Rb
Planavin®	>5000	>2000
PP 745® (Morfamquat dichloride)	368-800	
Prefix® (Chlorthiamid)	757	1000
Prometon (Prometone)	1750-3000	
Prometryne (Gesagard®)	2500	>1000
Propachlor (Ramrod®)	1200	380 Rb
Propanil (Stam F-34®, Surcopur®)	1300-1384	
Propazine	>5000	
Propham (IPC)	1000-9000	
Pyrazon (Pyramin®)	3300-4200	
Pyriclor (Daxtron®)	80-130	>2000
Quilan® (Benefin, Balan®)	>10,000	
Ramrod® (Propachlor)	1200	380 Rb
Randox® (Allidochlor, CDAA)	700	360
Reglone® (Diquat dibromide)	400-440	>500 Rb
Semeron® (Desmetryne)	1630-2375	>1000
Sesone (2,4-DES-Na, Disul)	700-1400	
Siduron	>7500	
Silvex® (Fenoprop, 2,4,5-TP)	650-1070	
Simazine (Gesatop®)	5000	
Simetryne	1830	
Sinbar® (Terbacil)	>7500	
Sirmate®	1870-2140	570-2500 Rb
Solan (Pentanochlor)	10,000	>10,000 Rb
Stam F-34® (Propanil, Surcopur®)	1300-1384	
Sulfallate (CDEC, Vegadex®)	850	

TABLE 5 (Continued)

	Oral LD_{50} a/ mg/kg	Dermal LD_{50} a/ mg/kg
Surcopur® (Propanil, Stam F-34®)	1300-1384	
Sutan®	4000	>2000 Rb
Swep	552	2480 Rb
2,4,5-T	300-800	
2,3,6-TBA	1500	>1000
Tenoran® (Chloroxuron)	3700	>10,000 Rb
Terbacil (Sinbar®)	>7500	
Terbutol (Azak®)	>34,600	>10,250
Thiuron (Methiuron)	2200	
Tillam® (Pebulate, PEBC)	1020-1120	>3000 Rb
Tordon® (Picloram)	8200	>4000 Rb
2,4,5-TD (Fenoprop, Silvex®)	650-1070	
Tri-allate (Avadex BW®)	800-1810	
Tribonate®	108	
Tricamba (Banvel-T®)	300-450	>1000
Trichloroacetates	3200-6000	
Trietazine	1750-3800	
Trifluralin	5000-10,000	>200 Rb
Vapam® (Metham-Na)	820	800 Rb
Vegadex® (Sulfallate, CDEC)	850	
Venzar® (Lenacil)	>11,000	
Vernolate (Vernam®)	1780	>9000 Rb
Zytron® (DMPA)	270	

II Insecticides and acaricides other than organophosphates

	Oral LD_{50} a/ mg/kg	Dermal LD_{50} a/ mg/kg
Aldicarb (Temik)	.93	5
Aldrin	40-60	>200
Allethrin	680-1000	11,200 Rb
Aminocarb (Metacil®)	30	
Animert® (Tetrasul)	6800->14,700	
Aramite®	4000-6000	
Arprocarb (Baygon®)	83-175	>1000
Binapacryl (Morocide®)	58-225	1350 Rb
Bromodan®	12,900	
Carbaryl (Sevin®)	400	>500
Chlorbenside (Chlorparacide®)	2000-10,000	
Chlordane	283	>1600
Chlordecone (Kepone®)	114-140	>2000
Chlorfenson	2000	
Chlorobenzilate	700-3200	>5000
Chloropropylate	>5000	>150
Chlorparacide® (Chlorbenside)	2000-10,000	
Chlorphenamide	340	
DDD (TDE)	400-3400	>5000 Rb
DDT	300-500	2500
Derris	1500	
Dicofol (Kelthane®)	575->2000	1000-1230
Dieldrin	40	>100
Dilan®	475-4000	6000
Dimetan®	140-150	
Dimethrin	>15,000	
Dimetilan®	25-50	600-700
Dimite®	500	
Dinobuton	140-460	2500-5000
Dithioquinox (Quinomethionate, Morestan®, Forstan®)	1100-3000	>1000
Endosulfan (Thiodan®)	35	74-130
Endrin	3-6	60-120
Eradex® (Thioquinox)	1800-3400	>3000
Fenazaflor (Lovozal®)	240	>1000
Fluoroacetamide	15	80
Forstan® (Quinomethionate, Dithioquinox, Morestan®)	1100-3000	>1000
gamma-BHC (Lindane)	200	500-1000
Genite®	1400-1900	
Heptachlor	40	200-250
Isobenzan (Telodrin®)	5-10	5-30
Isodrin	7-17	23-35
Isolan	12	35-60
Kelthane® (Dicofol)	575->2000	1000-1230
Kepone® (Chlordecone)	114-140	>2000
Lead arsenate	10-100	>2400
Lethane®	90-300	125-250 Rb
Lindane (gamma-BHC)	200	500-1000
Lovozal® (Fenazaflor)	240	>1000
Matacil® (Aminocarb)	30	
Methiocarb (Mesurol®)	100-135	
Methoxychlor	5000-7000	6000->6000
Mirex	600-740	>2000
Mobam®	>234	>6000 Rb
Morestan® (Forstan®, Dithioquinox®, Quinomethionate)	1100-3000	>1000
Morocide® (Binapacryl)	58-225	1350 Rb
Neotran®	5800	>1000 Rb
Nicotine	70	140
o-Dichlorobenzene	500	
Penphene® (Tetrachlorothiophene, TD 183®)	70->80	256 Rb
Perthane®	8170-9340	
Pyethrins	570	>1350->5400
Pyrolan®	50-90	
Quinomethionate (Dithioquinox, Morestan®, Forstan®)	1100-3000	>1000
Rotenone	25-132	>940 Rb
Ryania	750-1200	>4000 Rb
Sevin® (Carbaryl)	400	>500
Strobane®	200-250	>5000 Rb
Sulphenone®	1400-3650	>1000 Rb
(TD 183®, Tetrachlorthiophene, Penphene®)	70->80	256 Rb
TDE (DDD)	400-3400	>5000 Rb
Tedion® (Tetradifon)	5000-14,700	>10,000 Rb
Telodrin® (Isobenzan)	5-10	5-30
Temik®	0-6	2-5
Tetrachlorothiophene (Penphene®, TD 183)	70->80	256 Rb
Tetradifon (Tedion®)	5000-14,700	>10,000 Rb
Tetrasul (Animert®)	6800->14,700	
Thanite®	1600	6000 Rb

TABLE 5 (Continued)

	Oral LD$_{50}$ [a/] mg/kg	Dermal LD$_{50}$ [a/] mg/kg
Thiodan® (Endosulfan)	35	74-130
Thioquinox (Eradex®)	1800-3400	>3000
Toxaphene	283	>1000
Tranid®	17	200-400 Rb
Zectran®	15-63	1500-2500
III Organophosphorus insecticides		
Abate®	1000-4000	1370-4000
Amidothion (Thiocron®)	600-660	
Aspon®	1295	
Azinphos-ethyl (Ethyl, Guthion®)	9	280
Azinphos-methyl (Guthion®)	7-13	280
Baytex® (Fenthion)	200	1300
Bidrin®	22-45	225 Rb
Birlane® (Chlorfenvinphos)	10-155	108
Bromophos	3750-5180	>1000 Rb
Butonate	1050	>2000
Carbophenothion (Trithion®)	7-30	800
Chlorfenvinphos (Birlane®)	10-155	108
Chlorthion®	625-1500	1500-4500
Cidial®	200-300	700->1400
Ciodrin®	125	385 Rb
Co-Ral® (Coumaphos)	13-180	860
Coroxon	10	
Coumaphos (Co-Ral®)	13-180	860
Coumithoate (Dition®)	67	>200
Cygon® (Dimethoate)	200-300	700-1150
DDVP (Dichlorvos)	25-30	75-900
Delnav® (Dioxathion)	20-40	350
Demeton (Systox®)	3-5	200
Demeton-methyl (Metasystox®)	50-75	300-450
Demeton-S-methyl (Meta-iso-Systox®)	40	85
Diazinon	300-600	500->1200
Dibrom® (Naled)	430	800-1100
Dicapthon	330-475	800-1250
Dichlofenthion (Nemacide®)	250	
Dichlorvos (DDVP)	25-30	75-900
Dimefox (Terra-Sytam®, Hanane®)	2	2-10
Dimethoate (Rogor®, Cygon®)	200-300	700-1150
Dioxathion (Delnav®)	20-40	350
Dipterex® (Trichlorphon)	650	>2800
Disulfoton (Disyston®)	4	50
Dition® (Coumithoate	67	>200
Dowco 109® (Ruelene®)	460-1000	4000 Rb
Dow ET-14® (Fenchlorphos)	1000-3000	>5000
Dow ET-15®	710	>1000
Dursban®	135-163	2000 Rb
Dyfonate®	4-17	147
Ekatin® (Thiometon)	100	>200
Endothion	23	130
EPN	8-17	25-230
Ethion	13-34	1600
Ethoate-methyl (Fitios B-77®)	125	2000
Ethyl guthion® (Azinphos-ethyl)	9	280
Etrolene® (Fenchlorphos)	1000-3000	>5000
FAC 20® (Prothoate)	14-25	100-200
Fenchlorphos (Ronnel, Etrolene®, Dow ET-14®)	1000-3000	>5000
Fenitrothion (Sumithion®)	250-673	1500->3000
Fenthion (Baytex®, Lebaycide®)	200	1300
Fitios B-77® (Ethoate-methyl)	125	2000
Folimat®	50	700
Formothion	400	400-1680
Guthion® (Azinphos-methyl)	7-13	280
Haloxon	900-2000	>6000
Hanane® (Dimefox)	2	2-10
Imidan® (Prolate®)	113-230	>3160 Rb
Kilval® (Vamidothion)	64-100	1160 Rb
Lebaycide® (Fenthion)	200	1300
Malathion	1400-1900	>4000
Mercarbam	15	380
Menazon	1200-1600	>500
Meta-iso-Systox® (Demeton-S-methyl)	40	85
Metasystox® (Demeton-methyl)	50-75	300-450
Metasystox R® (Oxydemeton-methyl)	57	100
Methidathion (Supracide®)	20-48	25-400
Methyl Trithion®	98-200	190-215
Mevinphos (Phosdrin®)	3-5	90
Mocap®	61	26-46 Rb
Morphothion	200	283
Naled (Divrom®)	430	800-1100
Nemacide® (Dichlofenthion)	250	
Oxydemeton-methyl (Metasystox®)	57	100
Parathion	3-6	4-200
Parathion-methyl	12-16	67
Phenkapton Phenkaptone®	50	>1000
Phorate (Thimet®)	2-3	70-300
Phosalone (Zolone®)	120-170	390
Phosdrin® (Mevinphos)	3-5	90
Phosphamidon	15	125
Potasan®	19-40	300 Rb
Prolate® (Imidan®)	113-230	>3160 Rb
Prothoate (FAC 20®)	14-25	100-200
Pyrazothion	36	
Rogor® (Dimethoate, Cygon®)	200-300	700-1150

TABLE 5 (Concluded)

	Oral LD$_{50}$[a] mg/kg	Dermal LD$_{50}$[a] mg/kg
Ronnel (Fenchlorphos)	1000-3000	>5000
Ruelene® (Dowco 109®)	460-1000	4000 Rb
Schradan	5	50-100
Sulfotep	1-5	20 Rb
Sumithion® (Fenitrothion)	250-673	1500->3000
Supracide® (Methidathion)	20-48	25-400
Systox® (Demeton)	3-5	200
TEPP	0-5	20
Terra-Sytam® (Dimefox)	2	2-10
Thimet® (Phorate)	2-3	70-300
Thiocron® (Amidothion)	600-660	
Thiometon (Ekatin®)	<100	>200
Thionazin (Zinophos®)	9-16	8-15
Triamide	20	
Triamiphos (Wepsyn®)	10-20	1500-3000 Rb
Trichlorphon (Dipterex®)	650	>2800
Trithion® (Carbophenothion)	7-30	800
Vamidothion (Kilval®)	64-100	1160 Rb
Wepsyn® (Triamiphos)	10-20	1500-3000 Rb
Zinophos® (Thionazin)	9-16	8-15
Zolone® (Phosalone)	120-170	390

IV Fungicides

	Oral LD$_{50}$[a] mg/kg	Dermal LD$_{50}$[a] mg/kg
Allisan® (Dicloran)	1500-4040	
Binapacryl (Morocide®)	58-225	1350 Rb
Botran® (Dicloran)	1500-4040	
Captafol (Difolatan®)	4200-6200	>800 Rb
Captan (Orthocide®)	8400	
Chloranil	4000	
Copper salts	700-1000	>1000
Daconil®	>10,000	
Dazomet (Mylone®, DMTT®)	320-1000	>1000 Rb
DCMOD (Plantvax®)	2000	
Dehydroacetic acid (DHA)	500-1000	
Dichlofluanid (Elvaron®)	500-1000	>1000
Dichlone (Phygon®)	1300-2250	
Dichloran (Allisan®, Botran®)	1500-4040	
Difolatan® (Captafol)	4200-6200	>800 Rb
Dinitrotrichlorobenzene	500	
Dinocap (Karathane®)	2000	>9400 Rb
Dithianon	1000-1015	
Dithiocarbamates (Maneb, Zineb, etc.)	1000-8000	>1000
Dithioquinox (Quinomethionate)	1100-3000	>1000
(DMTT®, Dazomet)	320-1000	>1000 Rb
Dodine (Melprex®)	566	>1500 Rb
Dyrene®	2700	
Elvaron® (Dichlofluanid)	500-1000	>1000
Ethylmercuric salts	30	200
Fentin salts (Triphenyl tin salts)	238	450
Folpet (Phaltan®)	>10,000	
Forstan® (Quinomethionate)	1100-3000	>1000
Furidazole (Voronit®)	1100	>1000
Glyodin	6800	
Karathane® (Dinocap)	2000	>9400 Rb
Maneb: see dithiocarbamates		
Melprex® (Dodine)	566	>1500 Rb
Metham-Na (Vapam®)	820	800 Rb
Morestan® (Quinomethionate)	1100-3000	>1000
Morocide® (Binapacryl)	58-225	1350 Rb
Mylone® (Dazomet)	320-1000	>1000 Rb
Olin 1763®	>10,000	
Orthocide® (Captan)	8400	
PCNB (Quintozene)	1650-12,000	
Pentachlorophenol (PCP)	280	105-350
Phaltan® (Folpet)	>10,000	
Phenylmercuric salts	60	
Phygon® (Dichlone)	1300-2250	
Plantvax® (DCMOD)	2000	
Quinomethionate (Dithioquinox, Morestan®, Forstan®)	1100-3000	>1000
Quintozene (Terrachlor®, PCNB)	1650-12,000	
Sulphur	non-toxic	
Terrachlor® (Quintozene, PCNB)	1650-12,000	
Thiram (TMTD®)	375-1000	
Triphenyl tin salts (Fentin salts)	238	450
Vapam® (Metham-Na)	820	800 Rb
Voronit® (Furidazole)	1100	>1000
Zineb: see dithiocarbamates		

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[a] LD$_{50}$ in rats except where noted for rabbits (Rb).

TABLE 6

THRESHOLD LIMIT VALUES FOR RESPIRABLE PESTICIDE DUSTS, FUMES, AND MISTS[76a]/

Pesticide	TLV[a]/ ppm	TLV[a]/ mg/m^3
Abate®	--	15.0
Acrolein	0.1	0.25
Aldrin	--	0.25 (skin)
Ammonium sulfamate	--	15.0
Antimony and compounds (as Sb)	--	0.5
ANTU	--	0.3
Arsenic and compounds (as As)	--	0.5
Azinphos-methyl	--	0.2 (skin)
Calcium arsenate	--	1.0
Carbaryl	--	5.0
Carbon disulfide	20.0	60.0
Carbon tetrachloride	10.0	65.0
Chlordane	--	0.5 (skin)
Chloroform	50.0	240.0
1-Chloro-1-nitropropane	20.0	100.0
Chloropicrin	0.1	0.7
Coal tar pitch volatiles	--	0.2
Crag® herbicide	--	15.0
Cyanide (as CN)	--	5.0 (skin)
Cyanogen	10.0	--
2,4-D	--	10.0
DDT	--	1.0 (skin)
Demeton	--	0.1 (skin)
1,2-Dibromoethane (EDB)	25.0	190.0 (skin)
Dibutyl phthalate	--	5.0
o-Dichlorobenzene	50.0	300.0
p-Dichlorobenzene	75.0	450.0
1,2-Dichloroethane	50.0	200.0
Dichloroethyl ether	15.0	90.0 (skin)
Dichloromethane	500.0	1,740.0
1,1-Dichloro-1-nitroethane	10.0	60.0
1,2-Dichloropropane		
Dichlorvos (DDVP)	--	1.0 (skin)
Dieldrin	--	0.25 (skin)
Dimethyl 1,2-dibromo-2,2-dichloroethyl phosphate (Dibrom or Naled®)	--	3.0
Dinitro-o-cresol	--	0.2 (skin)
Endosulfan	--	0.1 (skin)
Endrin	--	0.1 (skin)

TABLE 6 (Concluded)

Pesticide	TLV[a/] ppm	TLV[a/] mg/m³
EPN	--	0.5 (skin)
Ethylene oxide	50.0	90.0
Ethyl formate	100.0	300.0
Ferbam	--	15.0
Fluoride (as F)	--	2.5
Formaldehyde	5.0	6.0
Heptachlor	--	0.5 (skin)
Hydrogen cyanide	10.0	11.0 (skin)
Lead arsenate	--	0.15
Lindane	--	0.5 (skin)
Malathion	--	15.0 (skin)
Mercury (inorganic compounds)	--	0.01 (skin)
Methoxychlor	--	15.0
Methyl bromide	20.0	80.0 (skin)
Methyl chloroform	350.0	1,900.0
Naphthalene	10.0	50.0
Nicotine	--	0.5 (skin)
Nitrobenzene	1.0	5.0 (skin)
Paraquat	--	0.5 (skin)
Parathion	--	0.1 (skin)
Pentachlorophenol	--	0.5 (skin)
Perchloroethylene	100.0	670.0
Phosdrin®	--	0.1 (skin)
Pival®	--	0.1
Pyrethrum	--	5.0
Ronnel	--	10.0
Rotenone (commercial)	--	5.0
Sodium fluoroacetate (1080)	--	0.05 (skin)
Strychnine	--	0.15
2,4,5-T	--	10.0
TEPP	--	0.05 (skin)
Thiram	--	5.0
Tin, organic compounds	--	0.1
Toxaphene	--	0.05 (skin)
Warfarin	--	0.1

[a/] Values given are maximum permissible concentrations in air for 8-hr day, 40-hr work week occupational exposures. Ambient air standards have not been established. The word "skin" denotes that the substance may also be absorbed through the skin, which makes it potentially more hazardous to handle.

Toxicity to Wildlife

The toxicity of pesticides to wildlife is often an important consideration. Quantitative data are meager, however, except for the results of rather extensive studies on toxicity to fish as shown in Table 7. The relative hazard[37] of about 70 insecticides to honey bees is shown in Table 8. A description of wildlife toxicity categories which has been used[76b] is as follows:

- Highly toxic means that severe losses may occur if the pesticide is used in or over a habitat containing the animals or organisms specified. "Use" of the pesticide in this context means use at recommended dosage levels, including such overuse as may be expected in normal operations from overlapping swaths, inadvertant double treatment, and/or miscalibration.

- Moderately toxic means that moderate losses of the animals or organisms may occur under the operating conditions outlined in the preceding paragraph.

- Slightly toxic means that slight losses or injury to nontarget animals or organisms may occur.

- Relatively nontoxic means that no losses or injury to nontarget species is likely to occur, allowing for a considerable margin of overuse, misapplication and/or miscalibration.

Environmental Persistence, Mobility and Effect

Persistence is a term which is used in many ways. It may refer to the continued existence of a chemical in any and all forms (including water, soil, air, and living plant and animal organisms), anywhere in the world after it has been used. Frequently it is used in a restricted sense, such as persistence in the soil. Even then, the persistence which is found depends on several factors such as: the analytical method (are metabolites included or excluded?); the type of soil; the microorganisms and the vegetation present; the moisture level (decay rates in muds and sediments may be very low for some normally nonpersistent pesticides), and the application rate (decay may be rapid at recommended application rates, but much slower if larger amounts are dumped in one place). While some pesticides break down to essentially nontoxic products very rapidly, other, such as organic-mercury compounds, leave a toxic residue even when the original compound has decomposed completely. The persistence can be roughly related to the time required for most (75-100%) of the pesticide to break down in the environment as follows.

TABLE 7

TOXICITIES TO FISH FOR SELECTED PESTICIDES[a]

INSECTICIDES

Pesticide	Species	TLm[a]	LC_{50}[b]
Abate®	Brook trout	1.5	
Aldrin[c]	Rainbow trout	0.003	0.05 (24)
	Bluegill		0.013 (96)
	Goldfish		0.02 (240)
	Goldfish		0.028 (96)
	Goldfish		0.05 (24)
Allethrin	Rainbow trout	0.019	
Azodrin	Rainbow trout	7.0	
Aramite	Bluegill	0.035	
Baygon®	Fathead	0.025	
Baytex®	Brown trout	0.080	
Benzene hexachloride	Rainbow trout	0.018	0.05 (-)
	Bass and bluegill		0.1 (-)
	Goldfish		0.23 (96)
Bidrin®	Rainbow trout	8.0	
Carbaryl (Sevin®)	Brown trout	1.5	
	Longnose killifish		1.75 (24)
	White mullet		4.25 (24)
	Fathead minnow		13.0 (96)
	Bluegill		5.6 (96)
Carbophenothion	Bluegill	0.225	
Chlordane[c]	Rainbow trout	0.010	0.05 (24)
	Bluegills		0.022 (96)
	Goldfish		0.05 (96)
	Goldfish		0.082 (96)
Chlorobenzilate	Rainbow trout	0.710	

TABLE 7 (Continued)

INSECTICIDES (Continued)

Pesticide	Species	TLm[a]	LC50[b]
Cryolite	Rainbow trout	47.0	
DDD (TDE)[c]	Rainbow trout	0.009	
	Goldfish		1.0 (-)
DDT[c]	Bass	0.002	
	Mosquitofish		0.01 (72)
	Goldfish		0.027 (96)
	Brook trout		0.0323 (36)
	Salmon		0.072 (-)
	Salmon		0.08 (36)
	Goldfish		0.1 (72)
	Mosquitofish		0.32 (36)
	Mosquitofish		0.5 (24)
Delnav® (dioxathion)	Bluegill	0.014	
Demeton (Systox®)	Bluegill	0.081	
Diazinon®[c]	Bluegill	0.030	
Dibrom® (naled)	Brook trout	0.078	
Dieldrin[c]	Bluegill	0.003	0.0008 (96)
	Bass		0.006 (-)
	Goldfish		0.006 (-)
	Goldfish		0.037 (96)
	Rainbow trout		0.05 (24)
	Goldfish		0.25 (-)
Dilan®	Bluegill	0.016	
Dimethoate	Bluegill	9.6	
Dimethrin	Rainbow trout	0.7	
Dichlorvos[c] (DDVP)	Bluegill	0.7	
Disulfoton	Bluegill	0.04	

TABLE 7 (Continued)

INSECTICIDES (Continued)

Pesticide	Species	TLm[a/]	LC$_{50}$[b/]	
Dursban®	Rainbow trout	0.020		
	Golden shiner		0.035	(36)
	Mosquitofish		0.215	(36)
	Green sunfish		0.022	(36)
Endosulfan (thiodan)	Rainbow trout	0.001		
Endrin[c/]	Bluegill	0.0002	0.0006	(96)
	Channel cats, large-mouth buffalo and gizzard shad		0.0001-0.002	(-)
	Bluntnose minnow		0.00027	(96)
	Coho salmon		0.00027	(96)
	Goldfish		0.00196	(96)
	Northern puffer		0.0031	(96)
	Fathead minnow		0.0018	(96)
	Carp		0.14	(48)
EPN	Bluegill	0.017		
	Fathead minnow		0.2	(96)
Ethion	Bluegill	0.23		
Guthion®	Rainbow trout	0.01		
Heptachlor[c/]	Rainbow trout	0.009	0.25	(24)
	Bluegill		0.019	(96)
	Goldfish		0.23	(96)
	Goldfish		0.063	(-)
Kelthane (dicofol)	Rainbow trout	0.1		
Kepone®	Rainbow trout	0.038		
Malathion[c/]	Brook trout	0.020		
	Fathead minnow		12.5	(96)
Methoxychlor[c/]	Rainbow trout	0.007	0.052	(24)
	Goldfish		0.056	(96)
	Guppies		0.120	(96)

TABLE 7 (Continued)

INSECTICIDES (Concluded)

Pesticide	Species	TLm[a]	LC_{50}[b]
Methyl parathion[c]	Bluegill	8,000	
Morestan®	Bluegill	96	
Ovex	Bluegill	700	
Paradichlorobenzene	Rainbow trout	880	
Parathion[c]	Bluegill	47	
	Fathead minnow		1.4-2.7 (96)
Perthane®	Rainbow trout	0.007	
Phosdrin®	Rainbow trout	0.017	
Phosphamidon	Rainbow trout	8.0	
Pyrethrins	Rainbow trout	0.054	
Rotenone	Bluegill	0.022	
Strobane®	Rainbow trout	0.002	
Tetradifon (tedion)	Bluegill	1.1	
TEPP[c]	Fathead minnow	0.39	
Thimet	Bluegill	0.005	
Toxaphene[c]	Rainbow trout	0.003	0.05 (24)
	Bluegill		0.0035 (96)
	Rainbow and brown trout		0.005 (-)
	Goldfish		0.0056 (96)
	Bluegill		0.0010 (-)
Trichlorfon (dipterex®)	Rainbow trout	160	
	Fathead minnow		180.0 (96)
Zectran®	Rainbow trout	8,000	

TABLE 7 (Continued)

HERBICIDES, FUNGICIDES, DEFOLIANTS, ALGICIDES

Pesticides	Species	TLm[a/]	LC$_{50}$[b/]
Ametryne®	Rainbow trout	3.4	
Aqualin® (acrolein)	Brown trout Bluegill		0.046 (24) 0.079 (24)
Atrazine	Rainbow trout	12.6	
Azide, potassium	Bluegill	1.4	
Azide, sodium	Bluegill	0.98	
Copper chloride	Bluegill	1.1	
Copper sulfate	Bluegill	0.15	
2,4-D, PGBEE	Rainbow trout	0.96	
2,4-D, BEE	Bluegill	2.1	
2,4-D, isopropyl	Bluegill	0.8	
2,4-D, butyl ester	Bluegill	1.3	
2,4-D, butyl + isopropyl ester	Bluegill	1.5	
2,4,5-T isooctyl ester	Bluegill	16.7	
2,4,5-T isopropyl ester	Bluegill	1.7	
2,4,5-T PGBE	Bluegill	0.56	
2(2,4-DP) BEE	Bluegill	1.1	
Dalapon	Very low toxicity		
Dead-X	Rainbow trout	9.4	
DEF®	Bluegill	0.036	
Dexon®	Bluegill	23.0	

TABLE 7 (Continued)

HERBICIDES, FUNGICIDES, DEFOLIANTS, ALGICIDES (Continued)

Pesticides	Species	TLm a/	LC$_{50}$ b/	
Dicamba		nontoxic		
Dichlobenil	Bluegill	20.0	20.0	(24)
	Rainbow trout		22.0	(48)
Dichlone	Rainbow trout	0.048		
	Bluegill		0.04	(24)
Difolatan®	Channel cat	0.031		
Dinitrocresol	Rainbow trout	0.21		
Diquat	Rainbow trout	12.3		
Diuron	Rainbow trout	4.3		
Du-ter®	Bluegill	0.033		
Dyrene®		0.015		
Endothall (Aquathol)	Bluegill	257		
Endothall, copper	Rainbow trout	0.29		
Endothall, dimethylamine	Rainbow trout	1.15		
Fenac®, acid	Rainbow trout	16.5		
Fenac®, sodium	Rainbow trout	7.5		
Hydram (molinate)	Rainbow trout	0.29		
Hydrothol 191	Rainbow trout	0.69		
Lanstan® (korax)	Rainbow trout	0.1		
LFN	Rainbow trout	0.079		
Molinate	Bluegill		0.48	(24)
	Rainbow trout		0.29	(48)

TABLE 7 (Concluded)

HERBICIDES, FUNGICIDES, DEFOLIANTS, ALGICIDES (Concluded)

Pesticides	Species	TLm[a]	LC_{50}[b]	
Paraquat		Very low toxicity		
Propazine	Rainbow trout	7.8		
Silvex, PGBEE	Rainbow trout	0.65		
Silvex, isoctyl	Bluegill	1.4		
Silvex, BEE	Bluegill	1.2		
Simazine	Rainbow trout	5.0		
Sodium arsenite	Rainbow trout	36.5	25.6	(96)
	Goldfish		34.0	(96)
	Bluegill		35.0	(96)
Tordon® (picloram)	Rainbow trout	2.5		
Trifuralin	Rainbow trout	0.011		
Vernam® (vernolate)[c]	Rainbow trout	5.9		

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[a] Adapted from Ref. 71. TLm is the 48-hr tolerance limit (mean) in ppm, causing a response. In this case the response was death and the TLm is essentially the same as LC_{50}.

[b] Adapted from Ref. 72. LC_{50} is the lethal concentration, in ppm, causing death of 50% of the fish in the number of hours indicated.

[c] According to Ref. 71 these pesticides are highly toxic when added directly to water, but become bound to soil when used according to directions.

TABLE 8

RELATIVE HAZARDS OF INSECTICIDES TO HONEY BEES[37]

Group 1 - Hazardous to Bees if They are Present at Time of Treatment or Within a Few Days Afterward

Aldrin
Arsenicals
Benzene hexachloride
Bidrin®
Calcium arsenate
Carbaryl
Chlordane
Ciodrin®
Diazinon®
Dichlorvos
Dieldrin
Dimethoate
EPN
Fenthion
Guthion®
Heptachlor
Lead arsenate
Lindane
Malathion
Methyl parathion
Methyl Trithion®
Mevinphos
Naled
Parathion
Phosphamidon
TEPP
Zectran®
Zinophos®

Group 2 - Hazardous to Bees Only if Applied Where They are Foraging

Carbophenothion
Chlorobenzilate
Coumaphos
DDT
Di-Syston®
Endosulfan
Endrin
Fenson
Mirex
Perthane®
Phorate
Ronnel
TDE

Group 3 - Relatively Nonhazardous to Bees

Allethrin
Aramite®
Binapacryl
Bordeaux mixture
Chlorbenzide
Cryolite
Dalapon
Demeton
Dilan®
Dioxathion
Ethion
Genite 923®
Kelthane®
Methoxychlor
Morestan®
Nicotine sulfate
Ovex
Pyrethrins
Rotenone
Ryania
Strobane®
Sulfur
Tetradifon
Toxaphene
Trichlorfon
Zineb
Ziram

Type	Time for 75-100% Disappearance
Nonpersistent	< 3 months
Moderately persistent	3-18 months
Persistent	> 18 months
Permanent	∞

In general, most organophosphate and carbamate insecticides are nonpersistent, while most highly chlorinated insecticides are persistent, and the heavy metal-containing compounds are permanent. The majority of the pesticides, however, probably fall in the moderately persistent category. Particularly with herbicides, the period of control desired is usually about one growing season, i.e., 6-12 months.

The relative persistence in soil of a number of pesticides of various classes is indicated in Figure 3. In addition to these data, the persistence of the chlorinated insecticides, DDD, endosulfan, endrin, lindane, and strobane, and the nitrogenous herbicides, atrazine, and diuron, have all been reported as > 1 year, while that of the herbicide trifluralin is in the range 3-12 months, and those of the insecticides--demeton, methyl parathion, mevinphos, and carbaryl--and the herbicide, pebulate--are all reported to be < 3 months,[40] The relative mobilities of a number of pesticides are given in Table 9.

An enormous literature on environmental aspects of pesticides is developing which is beyond the scope of this program. Recent publications of interest have come from governmental,[77] professional,[78,79] and other[80] sources.

TABLE 9

RELATIVE MOBILITY OF SELECTED PESTICIDES IN SOILS[40]

Immobile[a]	Slightly Mobile	Mobile
Aldrin	Atrazine	2,4-D
Chlordane	Simazine	2,4,5-T
DDT	Prometryne	MCPA
Dieldrin	Azinophosmethyl	Picloram
Endrin	Carbophenthion	Fenac
Heptachlor	Diazinon	
Toxaphene	Ethion	
TDE	Methyl parathion	
Trifluralin	Parathion	
Lindane[b]	Phorate	
Heptachlor epoxide[b]	Diuron	
	Monuron	
	Linuron	
	CIPC	
	IPC	
	EPTC	
	Pebulate	

---

[a] Mobilities are based on soil thin-layer chromatography--mobile compounds move between R_f 1.0-0.65, slightly mobile 0.64-0.10, and immobile 0.09-0.00. (R_f = "relative to fructose")

[b] Lindane and heptachlor epoxide may be slightly mobil.

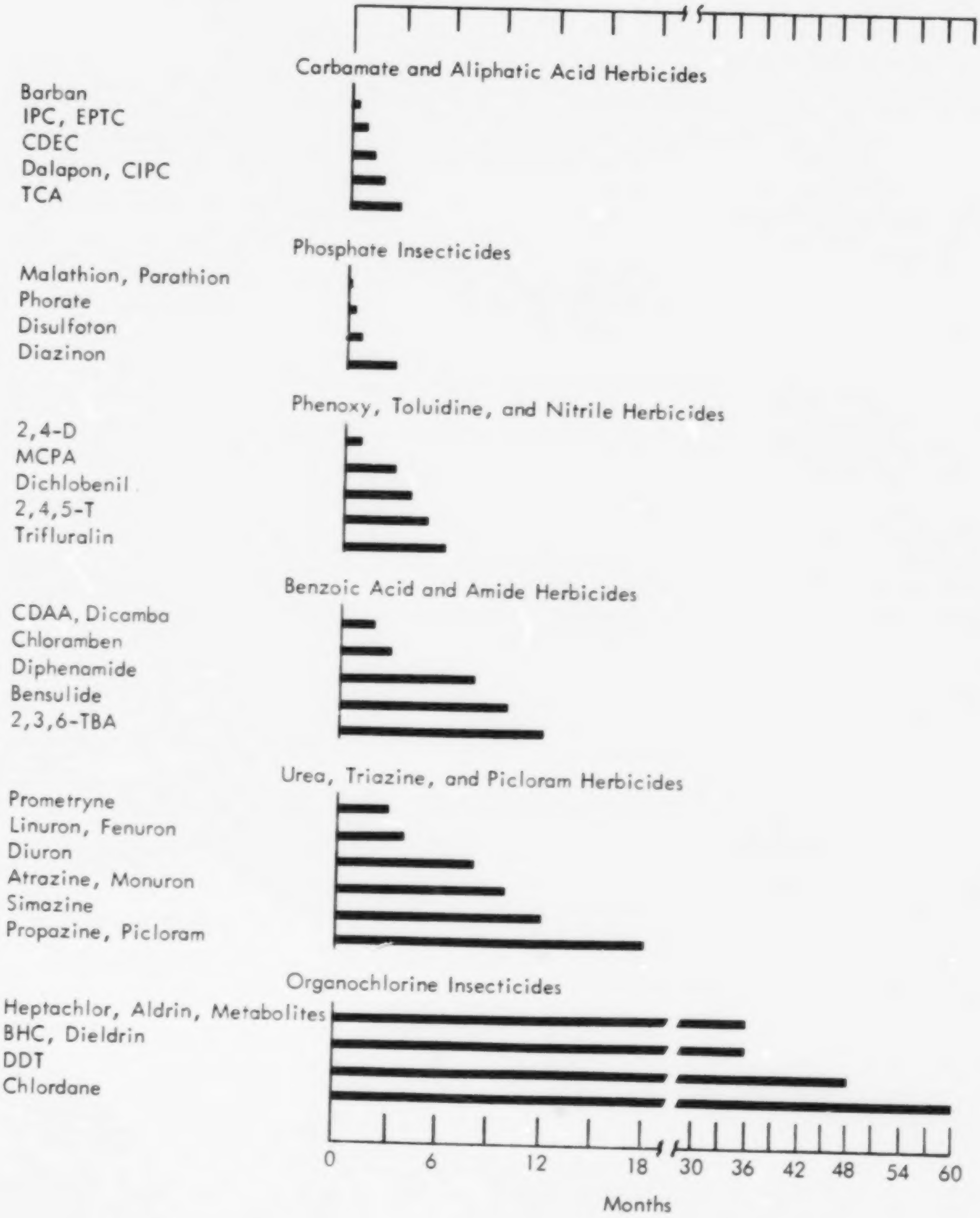

Figure 3 - Persistence of Selected Pesticides in Soils
(adapted from Ref. 81)

SECTION VII

REVIEW OF THE CHEMISTRY OF PESTICIDE DISPOSAL

In this section a review is made of the literature on the detoxification and disposal of pesticides in general classes and on the degradation chemistry of specific pesticides. The order in which the pesticides are discussed is according to the ranking system described in Section IV, and as indicated in the supplemental table of contents below.

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The specific pesticides within each group are listed at the beginning of the review on that group. When specific information on the degradation chemistry of a pesticide was not found, the compound is not further mentioned in the subsequent text.

Sources of information utilized include: references previously cited on pages 10 and 17; several books and review articles on pesticides,82-90/ including some devoted to analytical methods91-94/ (since analysis frequently involves chemical degradation of the pesticide); standard compilations such as Beilstein's Handbuch der Organische Chemie and Kirk-Othmer's Encyclopedia of Chemical Technology; and numerous other references cited in the text which have information on specific pesticides.

Although the biological and photochemical degradation reactions are reported for numerous pesticides the literature was not searched exhaustively for such reactions because few of them are amenable to use as a pesticide disposal method by the layman at present. Biological degradation methods using bacteria (under either aerobic or anaerobic conditions) or enzymes are of experimental interest, however, as potential methods of disposing of unwanted pesticides. Biological methods of increasing the rate of degradation of pesticide residues in soils are also of interest, e.g., by tillage methods and by growing selected vegetation. The focus in this section, however, is on chemical methods of detoxification, decontamination and degradation.

INORGANIC AND METALLO-ORGANIC PESTICIDES

The pesticides in this classification generally have one of two features in common: (a) They contain a heavy metal element (such as mercury, arsenic or thallium) or certain other inorganic elements (such as fluoride or boron) and therefore have a permanent-type of persistence, or (b) they pose special hazards in disposal because they may liberate extremely toxic fumes (such as with aluminum phosphide or calcium cyanide) or may form explosive mixtures (such as sodium or magnesium chlorate). In addition, a few other inorganic pesticides such as sulfur and ammonium sulfamate are included.

Mercury Compounds

Mercury-containing compounds came into wide use as fungicides (particularly as seed treatments) during the period 1950 to 1970, but are now declining rapidly in favor because of the toxicity of mercury residues in the environment. Mercury-containing pesticides which have been commercially available are listed below:

Ceresan® L
Ceresan® M
Elcide®
Emmi®
Ethylmercuric phosphate
Ethylmercury chloride
Hydroxymercurichlorophenol
Memmi®
Mercuric chloride and mercurous chloride
Methylmercuric hydroxide
3-Methyl-(mercurithio)-1,2-propanediol
Methylmercury nitrile
Ortho LM
Panogen®
PAS
2-(Phenylmercuriamino) ethyl acetate
Phenylmercuric ammonium acetate
Phenylmercuric borate
Phenylmercuric dimethyldithiocarbamate
Phenylmercuric hydroxide
Phenylmercuric lactate
Phenylmercuric naphthenate
Phenylmercuric oleate
Phenylmercuric propionate
N-Phenylmercury formamide
Phenylmercury urea
PMA
Semesan Bel®

All of the mercury-containing pesticides except mercuric and mercurous chlorides are organomercury compounds, i.e., they contain mercury-carbon bonds. Practically all of the organomercury pesticides are based on methylmercury, ethylmercury or the much less toxic phenylmercury salts. In March 1970 the U.S. Department of Agriculture suspended the use of all alkyl mercury compounds as seed treatments, and cancelled all use of mercury products for algicidal, slimicidal and laundering purposes because of the direct contamination of water. In early 1972, the Environmental Protection Agency suspended the registration of all alkyl mercury products, and the registrations of other mercury products for rice treatment, laundry uses and marine paints. Interstate shipment of 12 pesticides which contain mercury was halted.

Disposal of Mercury Pesticides

Although the EPA considers these mercury pesticides an "imminent hazard to the public," the Agency was quoted that the safest method of disposing of the mercury pesticide products would be "to proceed with normal use."[95] This recommendation would also appear to apply to seed which has been treated with mercury pesticides, since they cannot be used for any other purpose. The seed should not be burned and bulk burial is inadvisable.

Recovery of Mercury Values

At least two useful processes (described below) are known for recovering mercury metal from inorganic mercury, but no acceptable method exists at present for converting organomercury compounds to an inorganic mercury compound.

The mercury-carbon bond of organomercury compounds is remarkably stable; it is very resistant to both oxidation and hydrolysis.[96] The mercury-carbon bond of phenylmercuric chloride can be cleaved by hydrolysis, but the reaction is relatively slow (90% in 4 hr at 80°C using 0.4 M hydrochloric acid).[97] Bromine apparently cleaves this bond very rapidly and quantitatively.[98] Thus, the chemical evidence indicates that practical methods could be devised for converting organomercury compounds to inorganic mercury compounds, e.g., chlorination. However, no recommendation can be made until specific experiments are performed to demonstrate the reliability of such techniques.

Sulfide Procedure for Inorganic Mercury: A procedure for the ecologically satisfactory recovery of inorganic mercury compounds has been published by workers at the Environmental Protection Agency, Water Quality Office, Cincinnati, Ohio.[99] The procedure was developed for the purpose of recovering inorganic mercury salts left in wastes resulting from various analytical determinations, e.g., Chemical Oxygen Demand (COD), Kjeldahl nitrogen and Nessler ammonia. Basically, the procedure converts soluble mercuric salts to insoluble mercury sulfide. Mercury sulfide is the principal mercury ore and some refiners are willing to accept mercury sulfide precipitates. The recommended procedure is described below.

> "Dilute combined COD and other acidic wastes to about twice their original volume by slowly adding them to water, then adjust the pH to > 7 by slowly adding sodium hydroxide solution (40 to 50% w/v)

with vigorous stirring; this neutralization typically generates a large amount of heat, and dangerous spattering may occur if the sodium hydroxide is added carelessly. Combine the neutralized COD waste (with stirring) with any previously pooled wastes resulting from Kjeldahl nitrogen and Nessler ammonia determinations. At this point, the combined wastes should have a pH of 10 or higher; if not, add sodium hydroxide solution until a pH of 10 to 11 has been reached.

"While the combined alkaline wastes are still warm, intermittently stir in small portions of sodium thiosulfate solution (40 to 50% w/v), until no further precipitation seems to be occurring; this step is important, and it requires careful observation coupled with judgment. Immediately set the mixture aside, and allow the precipitate to begin settling. As soon as a few milliliters of clear supernatant can be drawn off, make sure its pH is still above 10, then add an equal volume of sodium thiosulfate solution. If the supernatant, thus being tested, still contains dissolved mercury, additional precipitate will rapidly form, indicating that sodium thiosulfate must again be added to the main batch of waste slurry.

"After an appropriate settling period, decant or siphon off the clear, previously tested supernatant and discard it. Slurry-wash the precipitate twice with water containing a trace of NaOH to remove sodium sulfate, allowing for reasonably complete settling each time; discard both of the clear washings. Dry the washed precipitate, first in air--i.e., at room temperature--then in an oven at a temperature not exceeding 110°C.

"Store the dry solids thus obtained until a sufficient quantity has accumulated to justify shipment to a commercial processor."

Sodium Borohydride Procedure for Inorganic Mercury: Another process for recovering mercury from inorganic salts is based on the reduction of mercurous or mercuric salts to elemental mercury using sodium borohydride. The process, developed by the Ventron Corporation, is said to be faster and more efficient than sulfide precipitation techniques.[100/]

Arsenic Compounds

Arsenic-containing pesticides include both inorganic arsenic and organoarsenic compounds as listed below. (Organoarsenic compounds are those which contain a chemical bond between arsenic and an organic group.)

Inorganic

Arsenic acid
Arsenious oxide
Calcium arsenate
Copper arsenate
Hexaflurate ($KAsF_6$)
Lead arsenate
London Purple
Magnesium arsenate
Sodium arsenate
Sodium arsenite

Metallo-Organic

Cacodylic acid
Calcium propylarsonate
CMA
DSMA
MAMA
MSMA
Paris Green

All arsenic compounds are toxic (the organo derivatives are generally less toxic) and there is no method for completely destroying their toxicity or the persistence of the arsenic in the environment. The natural level of arsenic in the earth's crust is about 5 ppm, however, according to the Handbook of Chemistry and Physics (Chemical Rubber Company).

The toxicity hazard of some inorganic arsenic compounds can be reduced by the formation of an insoluble product. Two techniques have been suggested[14] for calcium arsenate, arsenic acid and lead arsenate. (By analogy, the same procedures should be effective for arsenious oxide, London Purple, magnesium arsenate, sodium arsenate, sodium arsenite and Paris Green, a complex arsenite.)

The first procedure[14] is suggested for cases in which there is significant recovery value in the waste:

> "Dissolve in minimum hydrochloric acid (concentrated, reagent). Filter if necessary. Dilute with water until white precipitates form. Add just enough 6M HCl to redissolve. Saturate with hydrogen sulfide. Filter wash the precipitate, dry, package and ship to the supplier."

The second procedure[14] is suggested for arsenic wastes of very little value:

> "Add slowly to a large container of water. Stir in slight excess of soda ash. Let stand 24 hr. Decant or siphon into another container and neutralize with 6M HCl before washing down drain with large excess of water. The sludge may be added to land fill."

Most organoarsenic pesticides contain one or two methyl groups attached to the arsenic atom. Compounds of this kind (derivatives of alkyl arsenic acids) are very resistant to hydrolysis and are inert to such oxidizing agents as nitric acid, chlorine or bromine.[101] Thus, at present, there is no chemical method for converting organoarsenic compounds to inorganic arsenic compounds, and no recommended method for decreasing the toxicity hazard of organoarsenic compounds.

Incineration of organoarsenic compounds would produce arsenic oxide. This compound could be collected in alkaline scrubbing solutions as sodium arsenate, from which arsenic sulfide could be precipitated.[102]

Copper Compounds

Copper compounds have long been used as rodenticides, insecticides, fungicides and special purpose herbicides. The copper-containing pesticides can be classified as water-soluble, water-insoluble, or soluble in organic solvents, as indicated below:

Compound	Solubility[a]	
	Water	Organic Solvents
Bordeaux mixture	i	i
Cadmium-calcium-copper-zinc-chromate complex	i	i
Copper carbonate, basic	i	i
Copper naphthenate	i	s
Copper oleate	i	s
Copper oxychloride sulfate	i	i
Copper-8-quinolinolate	i	s
Copper salts of rosin and fatty acids	i	s
Copper sulfate	s	i
Copper zinc chromate	i	i
Cuprous oxide	i	i

---

[a] i = insoluble, s = soluble

Disposal of copper-containing pesticides presents problems similar to those encountered in disposing of arsenic and mercury pesticides; the fundamental toxic character of the metal cannot be destroyed. The copper compounds are generally quite toxic to fish and caution must be exercised not to form too high concentrations in water, e.g., even during normal use as an algicide.

The compounds can be rendered less dangerous by chemical conversion to relatively insoluble compounds. The Manufacturing Chemists Association suggests[14] that water-soluble copper compounds, such as copper sulfate, be converted to insoluble copper carbonates and disposed of by addition to a landfill.

Their procedure is as follows:

> "Add slowly to a large container of water. Stir in slight excess of soda ash. Let stand 24 hr. Decant or siphon into another container and neutralize with 6M HCl before washing down drain with large excess of water. The sludge may be added to landfill."

Since the rest of the inorganic copper-containing pesticides are relatively insoluble in water, no pretreatment would be required.

No disposal procedures have been recommended for the organic or "oil-soluble" copper-containing pesticides.

Other Heavy Metal Compounds

Two types of pesticides are considered here: those which contain a heavy metal which is inherently very toxic to mammals; those which contain a less toxic heavy metal and apparently do not pose so serious a degree of permanent environmental contamination.

More Toxic in Environment	Less Toxic in Environment
Antimony potassium tartrate	Bis(tri-n-butyltin)oxide
Cadmium succinate	Fentin acetate (Triphenyltin acetate)
Thallium sulfate	Triphenyltin hydroxide

Several other pesticides actually contain heavy metal atoms in their structures, but are not included here for practical purposes. For example, the dithiocarbamate salts of iron, zinc and manganese are grouped with the other dithiocarbamates.

Cadmium Succinate

Suggested[14/] procedures for disposing of cadmium salts are as follows:

> "Convert to nitrates with a minimum of nitric acid (concentrated, reagent). Evaporate in a fume hood to a thin paste. Add about 500 ml water and saturate with hydrogen sulfide. Filter, wash, and dry the precipitate. Package and ship to the supplier.

If the waste is of small volume, the following procedure is suggested:[14] Add slowly to a large container of water. Stir in slight excess of soda ash. Let stand 24 hr. Decant or siphon into another container and neutralize with 6M HCl before washing down drain with large excess of water. The sluge may be added to land fill."

Thallium Sulfate

Evidently, there is no presently known, acceptable method for detoxifying or disposing of thallium sulfate. Chemical methods for converting the compound to a more insoluble product are feasible (for example, the formation of an insoluble sulfide), but insufficient information is available concerning the usefulness of this technique for disposal purposes. The best present recommendation would be to suggest that the product be sent to a "professional disposal expert" whose best action would be to return it to the manufacturer.

Triphenyltin Hydroxide

It has been suggested[14] that tin organic compounds be dumped into landfills.

Cyanides, Phosphides and Related Compounds

Hydrogen cyanide, a gas at room temperature, and calcium cyanide, a salt which liberates gaseous hydrogen cyanide upon hydrolysis, are extremely toxic fumigants. Calcium cyanamide, an herbicide, soil sterilant, defoliant, fungicide and fertilizer; and potassium cyanate, an herbicide, are moderately toxic solids. The aluminum and zinc phosphides can liberate highly toxic phosphine gas and are included in this section because of their similarity to the cyanides. The formulas are indicated below:

Calcium cyanamide, $CaCN_2$
Calcium cyanide, $Ca(CN)_2$
Hydrogen cyanide, HCN
Potassium cyanate, KOCN

Aluminum phosphide, AlP
Zinc phosphide, Zn_3P_2

The Cyanides, Cyanates and Cyanamides

The cyanides are well known to be extremely toxic. Hydrogen cyanide is a gas, and calcium cyanide is a solid which releases HCN slowly in moist air or rapidly in acid: $Ca(CN)_2$ should never be treated with acid in disposal.

The cyanides are rapidly converted to the much less toxic cyanates by treatment with alkaline hypochlorite:

$$CN^- + ClO^- \xrightarrow[\text{pH } 10.0 - 11.5]{H_2O} CNO^- + Cl^-$$

This reaction forms the basis of the MCA procedure[14] for the treatment of "package lots" of cyanide wastes: "Add with stirring to strong alkaline solution of calcium hypochlorite. Let stand 24 hr. Flush the cyanate down the drain with large excess of water." In fact, however, the cyanate is also oxidized in mild alkaline hypochlorite to carbon dioxide and nitrogen, as shown by the equation:

$$2CNO^- + 3\ ClO^- + H_2O \xrightarrow[\text{pH } 7.0 - 9.5]{H_2O} 2CO_2 + N_2 + 3Cl^- + 2OH^-$$

Thus, the overall reaction for disposal of calcium cyanide with sodium hypochlorite would be:

$$Ca(CN)_2 + 6NaClO + H_2O \xrightarrow[\text{pH } 9.5]{} Ca(OH)_2 + 6NaCl + 2CO_2 + N_2$$

Hydrogen cyanide is not persistent in the environment and very small amounts of it could be disposed of alternatively by slow release to the atmosphere in a well ventilated outdoor location. Similarly, very small amounts of $Ca(CN)_2$ could be disposed of by exposure to moist air followed by water dilution.

Potassium cyanate (KOCN or KCNO) can be oxidized by hypochlorite, as indicated above, but it can be more easily destroyed by acidification, which converts it to carbon dioxide and an ammonium salt.

Calcium cyanamide is converted in either strong acid (pH < 2) or in strong base (pH > 12) to urea, NH_2CONH_2. It is also degraded to CO_2 and N_2 by alkaline hypochlorite

The Phosphides

Aluminum phosphide reacts readily with moisture or moist air to produce highly toxic phosphine gas, which is the basis of its fumigant activity. Also produced in this reaction is harmless alumina which does not present an environmental hazard. Phosphine gas reacts with air to produce nontoxic products. The reaction is normally slow, but mixtures can be explosive.

Thus, perhaps the best methods of disposing of aluminum phosphide is to allow it to react slowly with moisture out in the open, taking precaution to see that the poisonous gas (phosphine) is dissipated. Phosphine gas creates no permanent environmental hazard because it is eventually converted to harmless phosphorus acid and water.

Zinc phosphide reacts to produce phosphine only in the presence of aqueous acid. No method has been recommended for the disposal of zinc phosphide, but slow reaction with dilute acid (with precautions for phosphine as above) appears appropriate. Zinc is actually a heavy metal, but is not highly toxic. The residual zinc salts are more toxic than aluminum salts and thus present a greater, but normally not serious, environmental hazard.

Other Inorganic Compounds

Pesticides considered here are:

- AMS
- Borax
- Cryolite
- Lime sulfur
- Magnesium chlorate
- Silica gel
- Sodium chlorate
- Sodium fluoride
- Sodium fluosilicate
- Sodium metaborate
- Sulfur

AMS, Borax, and Sodium Metaborate

These water-soluble compounds are only moderately toxic and can be safely buried or washed down a sewer. AMS (ammonium sulfamate) is hydrolyzed to relatively harmless ammonium sulfate in soil.[103] The boron-containing compounds are phytotoxic and are permanent-type pollutants in soils receiving low rainfall.

Sulfur, Lime Sulfur, and Silica Gel

These water-insoluble compounds are also relatively nontoxic and can safely be buried or added to a landfill. Sand is an impure form of silica.

Sodium Fluoride, Cryolite and Sodium Fluosilicate

Sodium fluoride, cryolite (sodium aluminofluoride, Na_3AlF_6) and sodium fluosilicate (Na_2SiF_6) are sources of toxic fluoride ions which cannot be detoxified. Thus, precautions must be taken to insure that these materials do not enter a water supply in large amounts, but small amounts could be added to wastewaters, since fluoride is already present at trace levels in natural waters. A suggested[14] disposal method converts the soluble fluoride ions to insoluble calcium fluoride (LD_{50} = 5,000 compared to 200 for the soluble fluorides), a naturally occurring mineral (fluorspar) which can safely be added to a landfill. The method is as follows:

> "Add slowly to a large container of water. Stir in slight excess of soda ash. If fluoride is present add slaked lime also. Let stand 24 hr. Decant or siphon into another container and neutralize with 6 M HCl before washing down with large excess of water. The sludge may be added to landfill."[14]

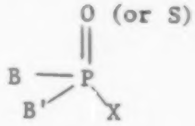
Sodium Chlorate - Magnesium Chlorate

Water-soluble chlorate compounds are of moderate toxicity, but are very strong oxidizing agents and should not be permitted to contact organic matter, especially in the absence of water. They can be chemically reduced to less dangerous products. The following procedure has been suggested:[14]

> "Add to a large volume of concentrated solution of reducer (hypo, a bisulfite, or a ferrous salt) and acidify with 3M H_2SO_4. When reduction is complete add soda ash or dilute hydrochloric acid to the solution. Wash into drain with large excess of water."

PHOSPHORUS-CONTAINING PESTICIDES

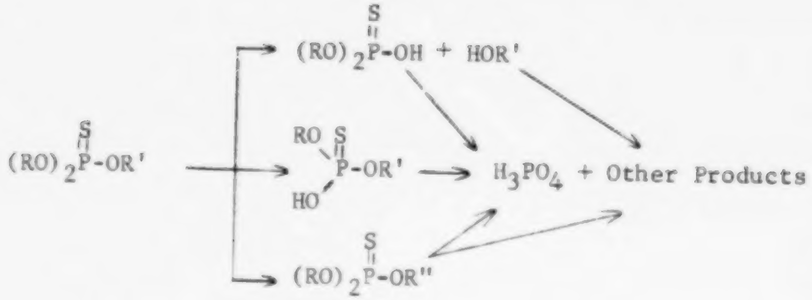
At least 80 phosphorus-containing organic compounds have been used as pesticides. Most of these are derivatives of pentavalent phosphorus and are of the general structural formula.



Where B and B' are basic groups (such as alkoxy or alkylamino) and X is a less basic or an acidic group. The exceptions to this generalized structure are the phosphite or quaternary phosphonium derivatives of trivalent phosphorus. The pentavalent phosphorus pesticides are nearly all insecticides (including larvacides, miticides, nematocides and one rodenticide) of the cholinesterase enzyme-inhibiting type: about 50 of these are highly toxic, i.e., oral LD_{50} of about 50 mg/kg or less, but a few have oral LD_{50}'s of over 1,000 mg/kg. The phosphorus-containing herbicides include two members of the pentavalent series (bensulide and DEF®), two phosphites (2,4-DEP and Folex®), all of which have $LD_{50} > 300$ mg/kg, and the plant growth regulators include the phosphonium salt (Phosfon®).

Hydrolysis of any one of the bonds between the phosphorus atom and either the acidic or a basic group in the structure above is reported to reduce, and in many cases, to destroy biochemical activity.[94,104] Hydrolysis, therefore, would appear to be a detoxification technique that would be applicable to this entire class of pesticides.

The hydrolysis may take place in alkaline, neutral or acidic media, but the relative rates at which hydrolysis occurs for the different bonds to phosphorus (or for bonds within the X group in the generalized structure above) can vary with conditions of pH, temperature, reactant concentrations, or the species in which the material is being metabolized (thus accounting for the great difference in toxicity between species of some specific compounds). Data are available in the literature on the hydrolysis rates under various conditions for many organophosphate insecticides, but these are primarily concerned with the initial steps of the reaction, i.e., those which destroy the high biochemical activity. In practice, several competitive and successive hydrolytic (or oxidative) reactions may occur as the phosphorus-containing pesticide is degraded to phosphoric acid and other simple products as indicated in the following example:



Hence, in order to recommend hydrolysis with complete confidence as a detoxification method, data on the reaction rates and hydrolysis products are required. In lieu of these data, a substantial excess of the hydrolytic agent (generally an alkali) should be used, e.g., a 3:1 or 5:1 mole ratio of sodium hydroxide to organophosphate.

The hydrolysis of trichlorfon illustrates this point. Trichlorfon $[(CH_3O)_2P(O)-COH_2CCl_3]$ is rapidly converted under mild alkaline conditions to dichlorvos $[(CH_3O)_2P(O)COHCCl_2]$, which, in turn, is hydrolyzed to $(CH_3O)_2P(O)OH$ and Cl_2CHCHO.[66] Dichlorvos, however, is significantly more toxic than the original active ingredient with an oral LD_{50} of 56 to 80 mg/kg vs 450 to 500 mg/kg for trichlorfon. Its dermal hazard is also greater, LD_{50} of 107 mg/kg vs > 2,000 mg/kg. The short-term effect of hydrolysis, under these conditions, therefore, is to increase the human hazard significantly (see Figure 1, p. 27), but under strongly alkaline conditions, the dichlorvos would also hydrolyze more rapidly.

Hence, much care must be exercised in the disposal of phosphorus-containing pesticides and in the disposal of containers which have held these toxic materials.[57,105]

Phosphates and Phosphonates

Compounds in this group are derivatives of phosphoric acid or the phosphonic acid obtained from it by replacement of hydroxyl with an organic group. Compounds included are:

Azodrin®
Bidrin®
Bomyl®
Butonate
Chlorfenvinphos
Ciodrin®
Dichlorvos
Dimethyl p-(methylthio)-
  phenyl phosphate
Ethephon

Fospriate
Gardona®
Glyphosate
Glyphosine
Mevinphos
Naled
NIA 10637
Phosphamidon
TEPP
Trichlorfon

Comments on degradation of specific compounds follow.

Azodrin®: Treatment of this product with water produces hydrolysis at a rate that is almost independent of pH in the pH range of 1 to 7 (50% hydrolyzed at pH 1 to 7 in 22 to 23 days at 38°C). At higher pH's the rate of hydrolysis rapidly increases.[8] This product is incompatible with alkaline pesticides.

Bidrin®: Bidrin® decomposes after 31 days at 75°C or 7 days at 90°C. Hydrolysis is 50% complete in aqueous solutions at 38°C after 50 days at pH 9.1 (100 days are required at pH 1.1). Alkaline hydrolysis (NaOH) yields $(CH_3)_2NH$.

Bomyl®: This compound is hydrolyzed by alkali (50% hydrolyzed at pH 5 after more than 10 days, at pH 6 after more than 4 days, at pH 9 less than 1 day.[8]

Butonate: Although more resistant to hydrolysis than trichlorfon (50% hydrolysis at pH 8 in 63 min), butonate is hydrolyzed rapidly in alkaline media to phosphoric, hydrochloric, and butyric acids.[83]

Ciodrin®: Hydrolysis of this product occurs readily; at 38°C it is 50% hydrolyzed after 35 hr at pH 9, or after 87 hr at pH 1. All formulations are unstable on most solid carriers.[83,106]

Dichlorvos: Fifty percent hydrolysis is obtained in pure water in 25 min at 70°C, and in 61.5 days at 20°C. A buffered solution yields 50% hydrolysis (37.5°C) in 301 min at pH 8, 462 min at pH 7, 4,620 min at pH 5.4. Hydrolysis yields no toxic residues. Dichlorvos is a hydrolysis product of trichlorfon.[83,92]

Dimethyl-p-(methylthio)phenyl phosphate: The alkaline hydrolysis rate of this compound at pH 9.5 and 37.5°C is $3.6 \times 10^{-5}\ \text{sec}^{-1}$.[8]

Ethephon: Ethephon is stable in aqueous solutions below pH 3.5; at higher pH, disintegration yields free ethylene, and chloride and phosphate ions.[83]

Gardona®: Fifty percent hydrolysis (at 50°C) is obtained in 1,300 hr at pH 3 and in 80 hr at pH 10.5.[8]

Mevinphos: Mevinphos is 50% hydrolyzed in aqueous solutions at an unspecified temperature in 1.4 hr at pH 11, 35 days at pH 7, and 120 days at pH 6. Decomposition is rapidly accomplished by lime sulfur. Mevinphos is incompatible with alkaline pesticides.[8]

Naled: This pesticide is more stable to hydrolysis than dichlorvos (50% hydrolysis at pH 9 at 37.5°C in 301 min). It is unstable in alkaline conditions, in presence of iron, and is degraded by sunlight. About 10% hydrolysis per day is obtained in ambient water.[83,92]

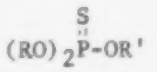
Phosphamidon: Fifty percent hydrolysis at 23°C requires 13.8 days at pH 7, and 2.2 days at pH 10. Bioactivity is reduced by copper oxychloride.[8]

TEPP: TEPP is 50% hydrolyzed in water in 6.8 hr at 25°C, and 3.3 hr at 38°C; 99% hydrolysis requires 45.2 hr at 25°C, or 21.9 hr at 38°C. Hydrolysis of TEPP yields nontoxic products.[86]

Trichlorfon: Trichlorfon initially hydrolyzes to the more toxic compound dichlorvos (LD_{50} of 56 mg/kg vs 450 mg/kg for trichlorfon[66]) at pH 8 and 37.5°C. Trichlorfon is essentially 100% hydrolyzed in approximately 24 hr to nontoxic products.

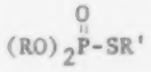
Phosphorothioates and Phosphonothioates

Compounds in this group have one sulfur atom attached to the phosphorus atom, and most of the commercial products of these compounds have the thiono structure below rather than the thiolo structure:



$(RO)_2\overset{S}{\overset{\|}{P}}\text{-}OR'$

Thiono



$(RO)_2\overset{O}{\overset{\|}{P}}\text{-}SR'$

Thiolo

Compounds included in this group are:

Abate®
Akton®
Aspon®
Bromophos
Bromophos ethyl
O-(*p*-(*p*-Chlorophenylazo)phenyl) O,O-dimethyl phosphorothioate
S-[(*p*-Chlorophenyl)thio]methyl O,O-diethyl phosphorothioate
Chlorpyrifos
Coumaphos
Cyanophos
O-(*p*-Cyanophenyl) O-ethyl phenylphosphonothioate
Cythioate
Demeton
Diazinon®
Dicapthon
2-(2,4-Dihydroxyphenyl)-1-cyclohexene-1-carboxylic acid-δ-lactone
  O,O-diethyl phosphorothioate
O,O-Dimethyl-O-*p*-(dimethylsulfamoyl)phenyl phosphorothioate
Endothion
EPN

Fenitrothion
Fensulfothion
Fenthion
Leptophos
2-Methoxy-4H-1,3,2-benzodioxaphosphorin 2-sulfide
Methyl-demeton
Methyl parathion
Nemacide
Parathion
Primiphos ethyl
Primiphos methyl
Ronnel
Salithion
Tetraethyl dithiopyrophosphate
Zinophos®

The thiolo isomer of a given phosphorothioate is more toxic to mammals as well as more thermally stable than the thiono isomer; most thiono derivatives rearrange to the thiolo form when heated mildly (100°C) or when treated with certain reagents. Some of the thiono compounds, e.g., parathion, have been reported[83] to undergo this rearrangement with explosive violence when heated strongly. Hence, high concentrates of these compounds should not be heated or treated with reagents that may cause excessive heating. Concentrates of these pesticides should be first diluted before disposal.

Exceptions to the generalized thiono structure above include endothion, which has the thiolo structure, and EPN and leptophos, in which one of the RO groups is replaced by an aryl group, i.e., they are actually phosphono compounds.

Phosphorothioates are generally susceptible to alkaline hydrolysis, but the rate varies. The addition of hypochlorite is probably helpful, particularly in removing residual odors left after cleanup of a spill. Comments on the degradation of specific compounds follow.

Abate®: No hydrolysis was observed after several hours at 40°C and pH 11, or at pH 8 and room temperature for several weeks.[83] Essentially complete hydrolysis occurred upon heating in concentrated KOH for 20 min.[107]

Aspon®: Aspon® is stable in water at 100°C for at least 24 hr. However, it decomposes without explosive hazard at 149°C.[8]

Bromophos: This compound is 50% hydrolyzed at pH 13 and 22°C in 3.5 hr. Bromophos is stable at pH 9. Dichlorobromophenol is the product of hydrolysis.[83]

Bromophos ethyl: Bromophos ethyl is slowly hydrolyzed via de-ethylation at pH 9 in aqueous alcohol solution. At higher pH, the phenol is removed.[8]

Chlorpyrifos: This compound is 50% hydrolyzed in aqueous MeOH solution at pH 6 in 1,930 days, and in 7.2 days at pH 9.96.[8] Spray mixtures of < 1% concentration are destroyed with an excess of 5.25% sodium hypochlorite in < 1/2 hr at 100°C, and in 24 hr at 30°C. Concentrated (61.5%) mixtures are essentially destroyed by treatment with 100:1 volumes of the above sodium hypochlorite solution and steam in 10 min.[109]

Coumaphos: This compound is completely decomposed on heating with concentrated alkali. It is oxidized with HNO_3 or other oxidizing agents to the phosphate analogue, Coroxon. Dilute alkali (pH 8-12) causes an opening of the pyrone ring, which can be closed again by acidification to yield the original compound.[83,92,108]

Demeton: The thiono- and thiolo-isomers of this mixture are 50% hydrolyzed in 75 min and 0.85 min, respectively[83] at 20°C and pH 13. At pH 9 and 70°C, the half life of demeton is 1.25 hr, but at pH 1-5 it is over 11 hr.[111]

Diazinon : Diazinon is hydrolyzed in acid media about 12 times as rapidly as parathion, and at about the same rate as parathion in alkaline media. In excess water this compound yields diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine. With insufficient water, highly toxic tetraethyl monothiopyrophosphate is formed.[83]

Dicapthon: The chemical properties are analogous to chlorthion: fifty percent hydrolysis at pH 5 and 20°C in 5.3 hr.[83]

2-(2,4-Dihydroxyphenyl)-1-cyclohexene-1-carboxylic acid-δ-lactone O,O-diethylphosphorothioate: This compound is resistant to hydrolysis at pH 5 to 8. Only at high pH is hydrolysis substantially accelerated. Initial hydrolysis takes place on the ethyl group to yield the thiophosphoric acid which has low insect and animal toxicity.[83]

Endothion: Endothion is hydrolyzed by alkali to form O-methyl-S-(S-methylpropyl-2-methyl) thiophosphate, which has low toxicity for animals and insects. One-half gram of endothion in 50 ml (cold) 1N NaOH is hydrolyzed in 15 min.[8,110]

EPN: EPN, a phosphono compound, is incompatible with alkaline pesticides. It is relatively rapidly hydrolyzed in alkaline medium to benzene thiophosphoric acid, alcohol and *p*-nitrophenol.[8,83]

Fensulfothion: This compound is readily oxidized to the sulphone and apparently isomerized readily to the S- ethyl isomer.[8]

Fenthion: Fenthion is more resistant to hydrolysis and heating than methyl parathion: 50% hydrolysis at 80°C in acid medium requires 36 hr, or 95 min in alkaline medium.[8,83]

Methyl-demeton: Methyl-demeton is less stable than demeton. Fifty percent hydrolysis at 70°C requires 1.25 hr at pH 9 and 4.9 hr at pH 3.[83,111]

Methyl parathion: This compound is subject to hydrolysis: 50% in 210 min in 0.01N NaOH at 30°C, and 32 min in 1N NaOH at 15°C.[90] Heating to 140° to 160°C sometimes takes place explosively.[83] (See also parathion below.)

Nemacide: Nemacide is stable to hydrolysis except under strong alkaline conditions.[8]

Parathion: Parathion is relatively resistant to hydrolysis: Fifty percent hydrolysis at 70°C and pH 9 requires 2.7 hr; 17 to 20 hr at 70°C and pH 1 to 5; and 690 days at 20°C and pH 1 to 5. This compound is subject to reduction by metals in acid media (as Zn in 9 part HOAc and 1 part HCl) to yield 0,0-diethyl 0-(4-aminophenyl)thiophosphate (aminoparathion) which is nontoxic to animals and does have an insecticidal effect.[83,103,104,111,112] One manufacturer (private communication) recommends the use of a detergent in a 5% trisodium phosphate solution for parathion disposal and cleanup problems.

Ronnel: This compound is stable in both neutral and acid media at 60°C. It is incompatible with alkaline pesticides and is hydrolyzed in weakly alkaline medium to the mono 0-methyl compound. Hydrolysis in strongly alkaline media yield mainly $(CH_3O)_2P(S)OH$, and 2,4,5-trichlorophenol (LD_{50} 150 to 250 mg/kg). Ronnel is saponified with concentrated HCl to produce 2,4,5-trichlorophenol.[8,14,92]

Sumithion: Hydrolysis rate for this compound is lower than that of methyl parathion. Fifty percent hydrolysis at 30°C requires 272 min in 0.01N NaOH and 12 min in 0.1N NaOH.

Tetraethyl dithionopyrophosphate (ADR) is resistant to hydrolysis.[11]

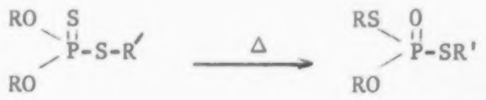
Zinophos®: Analysis is accomplished by hydrolysis. No other information has been found.

Phosphorodithioates and Phosphonodithioates

Compounds in this group have two sulfur atoms attached to the phosphorus atom. In almost all cases the structure is of the >P(S)-S-type; a few, however, are of the $-P(O)(-S-)_2$ type. Compounds included are:

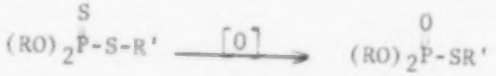
S-(2-Acetamidoethyl) O,O-dimethyl phosphorodithioate
Amidithion
Azinphosethyl
Azinphosmethyl
Bensulide
Carbophenothion
S-(*p*-Chlorophenyl) O-ethyl ethanephosphonodithioate
Dialifor
Dimethoate
Dioxathion
Disulfoton
Dyfonate®
Ethion
Ethoate-methyl
S-[(2-Ethylthio)ethyl]O,O-dimethyl phosphorodithioate
Formothion
Imidan®
Malathion
Mecarbam
Menazon
Methidathion
Methyl trithion
Phenthoate
Phorate
Phosalone
Prophos
Prothoate

Dithiophosphates, like the monothiophosphates (page 68) can rearrange on heating. The thiolo-thiono isomer, the more common case, is converted to the di-thiolo isomer when heated as shown in the following example.



For some dithiophosphates, such as malathion, the reaction is reported[83] to proceed smoothly at 150°C with pure material, but to become explosive at higher temperatures or to occur at lower temperatures when certain impurities are present. Hence, high concentrates of these materials should not be heated or treated with reagents which might generate excessive heat; they should be diluted first.

In oxidation of a dithiophosphate, the thiono sulfur atom can be replaced by an oxygen atom to give a product which may be much more toxic:[83]



$$(RO)_2\overset{S}{P}\text{-S-R}' \xrightarrow{[O]} (RO)_2\overset{O}{P}\text{-SR}'$$

Hence, oxidative conditions must be used with caution.

The dithiophosphates are generally susceptible to hydrolysis by base, as well as by acid. As in the case of the example given for monothio compounds (page 65), the hydrolysis may proceed differently for different compounds and under different conditions of pH, temperature and concentrations of reactants. A series of reactions are ultimately involved before complete degradation is attained. Hydrolysis of the dithiophosphates tends to be more difficult in alkaline media than is the case with the monothio compounds, and the addition of hypochlorite is probably helpful.

Comments on the degradation of specific compounds follow:

Amidithion: Chemical properties of amidithion are similar to those of dimethoate. It is hydrolyzed by alkali and is incompatible with alkaline pesticides.[8,83]

Azinphosethyl: This compound is thermally stable but "readily" hydrolyzed by alkali.[8] Analysis is accomplished by alkaline hydrolysis to give dialkyl phosphorodithioic acid. Other chemical properties are similar to azinphosmethyl.[83]

Azinphosmethyl: Although this compound is chemically stable in storage, it is decomposed at elevated temperatures with evolution of gas, and rapidly decomposed in cold alkali to form anthranilic acid and other decomposition products.[8,92] Fifty percent hydrolysis at pH 9 and 70°C requires 0.6 hr; 8.9 hr at pH 5 and 70°C, 240 days at pH 5 and 20°C.[111]

Bensulide: Bensulide is stable at 80°C for 50 hr, but decomposes at 200°C in 18 to 40 hr. It is noncorrosive.[8] The manufacturer (private communication) states that they use 20% hydrochloric acid for disposal. Alkaline hydrolysis may be effective also.

Carbophenothion: This compound is reported to be "rapidly" decomposed by hypochlorite.[113] Hydrolysis rates are 37% in 2 hr in NaOH (pH 13.1) at 20°C and no decomposition in HCl (pH 1.0) in 24 hr at 60°C.[92]

Dialifor: Dialifor is reported to be readily hydrolyzed by strong alkali.[8]

Dimethoate: Dimethoate is thermally unstable and decomposes on heating after first being converted to the more toxic dithio-isomer.[83] It is hydrolyzed more rapidly in alkaline medium: 50% hydrolysis at 70°C at pH 9, in 0.8 hr, and 21 hr at pH 2.[8,83]

Dioxathion: This compound is hydrolyzed by alkali and on heating. It is unstable on iron or tin surfaces and with certain carriers, and decomposes at 130 to 140°C yielding $(EtO)_2P(S)SH$ and $R\text{-}SP(S)(OEt)_2$. Dioxathion is oxidized to corresponding P=O compound.[8,83]

Disulfoton: Disulfoton is resistant to hydrolysis in acid media. Fifty percent hydrolysis at 70°C requires 60 hr at pH 5, and 7.2 hr at pH 9. It is hydrolyzed by refluxing with 1N KOH in i-PrOH in 30 min.[83,92,111]

Dyfonate®: Dyfonate®, a phosphono compound, is reported to be satisfactorily decomposed by hypochlorite.[113]

Ethion: Analysis of this compound is accomplished by hydrolysis to form diethyl phosphorodithioic acid. Ethion is subject to both acid and alkaline hydrolysis and is slowly oxidized in air.[8,83,114]

Ethoate-methyl: Ethoate-methyl is slowly oxidized by air. It is subject to hydrolysis by both acids and alkalis. Fifty percent hydrolysis at room temperature at pH 11 requires 72 min. Product analysis is accomplished by hydrolysis in 1:1 HCl, and steam distillation of the ethylamine produced.[8]

Formothion: Formothion is similar to dimethoate, but more stable in storage and on heating. It is hydrolyzed by alkali and is incompatible with alkaline pesticide. Analysis is accomplished by a modified hydrolysis.[8,83]

Imidan®: Imidan® is reported to be rapidly decomposed with hypochlorite. Fifty percent hydrolysis at room temperature in a buffered solution of initial Imidan® concentration of 20 ppm requires 13 days at pH 4.5, < 12 hr at pH 7, and < 4 hr at pH 9.3.[113]

Malathion: Malathion is reported to be "hydrolyzed almost instantly" at pH 12; 50% hydrolysis at pH 9 requires 12 hr.[50] Alkaline hydrolysis under controlled conditions (0.5N NaOH in ethanol) gives quantitative yields of $(CH_3O)_2\text{-}P(S)SNa$,[92] whereas hydrolysis in acidic media yields[83] $(CH_3O)_2P(S)OH$. On prolonged contact with iron or iron-containing material, it is reported to break down and completely lose insecticidal activity.[83]

Mecarbam: This compound is compatible with all but highly alkaline pesticides. At pH 3, it is hydrolyzed to $(EtO)_2P(S)SCH_2COOH$, CO_2, EtOH, and CH_3NH_2.[8,83]

Menazon: Menazon is compatible with all but strongly alkaline pesticides. It may be decomposed by reactive surfaces of some "inert" fillers.[8,83]

Methyl trithion: This compound is resistant to hydrolysis because of low water solubility. Fifty percent hydrolysis at an unspecified temperature requires 32 days at pH 8.3 (initial methyl trithion concentration of 0.6 ppm); 83 days at pH 4.6 (initial concentration of 0.6 ppm); and 64 days in distilled H_2O (initial concentration of 1.0 ppm).[92]

Phenthoate: Phenthoate is stable in acid and neutral media. In a buffered solution of pH 9.7, approximately 25% is hydrolyzed after 20 days.[8]

Phorate: Phorate is relatively unstable to hydrolysis, and is incompatible with alkaline pesticides.[83] Fifty percent hydrolysis requires 2 hr at pH 8 and 70°C, and 9.6 hr at pH 1 to 5 and 40°C.[111] Phorate is easily oxidized to the corresponding sulfoxide, which is more resistant to hydrolysis.[92]

Phosalone: Phosalone is readily hydrolyzed in alkaline medium. The principal hydrolysis products are 6-chlorobenzoxazolone, $(EtO)_2P(O)OH$, and formaldehyde.[83]

Prophos: This compound is very stable in acid aqueous media from 25 to 100°C. It is hydrolyzed moderately faster in basic media at 25°C and rapidly at 100°C. Prophos is thermally stable for 8 hr at 150°C.[115]

Prothoate: Prothoate is analogous to dimethoate, but more stable in storage. It is stable in neutral, moderately acid or slightly alkaline media. Prothoate decomposed in approximately 48 hr at pH 9.2 and 50°C.[8,83]

Phosphorus-Nitrogen Compounds

This group includes six insecticides which have the structural unit >P(O)-N< and one herbicide (DMPA) and one rodenticide (Gophacide®) which have the structural unit >P(S)-N<.

Acephate
Crufomate
Cyolane®
Dimefox
DMPA
Gophacide®
Monitor®
Schradan

Crufomate: Crufomate is stable at pH 7.0 or below, but is incompatible with alkaline pesticides.[8]

Cyolane®: Although Cyolane® is stable under neutral or acid conditions, it is hydrolyzed by alkali, and is nonpersistent in soil.[8]

Dimefox: This compound is stable in aqueous solutions;[83] and is resistant to hydrolysis by alkali. It is hydrolyzed by acids, slowly oxidized by vigorous oxidizing agents, and rapidly oxidized by chlorine. Treatment with acids followed by bleaching powder has been recommended for decomposition. Acid hydrolysis yields amine.[8] Equipment contaminated with dimefox can be decontaminated with hypochlorite.[104]

DMPA: DMPA is stable in acid and alkaline media and at temperatures to 70°C. It decomposes at 150°C.[8]

Gophacide®: This compound is reported to be unstable to alkali.[8]

Monitor®: Monitor® is stable in the pH range of 3 to 8. Hydrolysis by acids and alkalis increased with temperatures. It is compatible with most pesticides, but mixing with lime sulfur or Bordeaux mixture should be avoided.[116]

Schradan: This compound is stable in aqueous solutions. Fifty percent hydrolysis at 25°C requires 100 years in neutral solution, 70 days in 1N NaOH, and 200 min in 1N HCl. In water, an excess of chlorine leads to complete breakdown to nontoxic compound.

Other Phosphorus Compounds

The compounds included in this section are three herbicides, one plant growth regulator, and one repellent. They are:

Decyltriphenylphosphonium bromochlorotriphenylstannate
Def®
2,4-DEP
Folex®
Phosfon®

Def®: Def® is slowly hydrolyzed under alkaline conditions.[8]

2,4-DEP: Although this compound is stable when anhydrous, it is hydrolyzed in the presence of water to 2,4-dichloro-phenoxy ethanol and phosphoric acid. This reaction is accelerated by acids.[8]

Folex®: Folex® is slowly hydroxlyzed in water to form butyl mercaptan. The rate of hydrolysis is increased by alkali. It is slowly oxidized by oxygen in air to the phosphate, a reaction which is accelerated by heating.[83]

NITROGEN-CONTAINING PESTICIDES

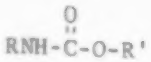
The nitrogen-containing class of pesticides--over 200 compounds--have a wide diversity of chemical structures and pesticidal activity. Chemically, they can be broadly grouped as follows:

- * Carbamates and related compounds
- * Amides, anilides and related compounds
- * Ureas and uracils
- * Triazines
- * Quaternary ammonium compounds
- * Nitro compounds
- * Other

With the exception of about 25 N-alkyl carbamates (which are insecticides of the cholinesterase-inhibiting type) and a few other compounds of diverse structures and uses, most of these compounds are either herbicides (generally selective) or fungicides.

Carbamates and Related Compounds

Carbamates of pesticidal importance are esters of N-substituted carbamic acid of the general formula.



$$RNH-\overset{O}{\overset{\|}{C}}-O-R'$$

where R and R' are either alkyl or aryl groups.

The carbamate pesticides consist of two major types: the larger N-alkyl group of insecticides and a small group of N-aryl herbicides. Most of the N-alkyl group are also the aryl ester (R' = aryl group) of the carbamic acid. The remaining six are of diverse structures, including an oxime, an acetamidate, as well as true carbamates. The carbamate pesticides are as follows:

N-alkyl Carbamates		N-aryl Carbamates and
Aryl Ester	Other	Related Compounds
Baygon®	Aldicarb	Asulam
o-sec-Butylphenyl N-methylcarbamate	Dichlormate	Barban
3,5-di-*t*-Butylphenyl N-methylcarbamate	Dimetilan	Benomyl
Bux Ten®	Karbutilate	Chlorpropham
Carbaryl	Methomyl	Propham
Carbofuran	Oxamyl	Swep
Carzol (formetanate hydrochloride)	Pirimicarb	
o-Chlorophenyl N-methylcarbamate		
Formetanate		
m-Isopropylphenyl N-methylcarbamate		
o-Isopropylphenyl N-methylcarbamate		
Landrin®		
Matacil®		
Mesurol®		
Mexacarbate		
Mobam®		
Phenmedipham		
Promecarb		
Sok®		
Terbutol		
m-Tolyl N-methylcarbamate		
3,4-Xylyl N-methylcarbamate		

With a few exceptions the N-alkyl carbamates have moderate to high acute oral toxicities ($LD_{50} < 500$) and display anticholinesterase activity while the N-aryl carbamates present a less acute toxic hazard ($LD_{50} > 500$).

N-Alkyl Carbamates: Residue studies indicate that carbamates largely disappear from the environment during the few months of the growing season. Detailed studies of the metabolic fate of typical O-aryl carbamate pesticides using intact enzyme systems,[117] or isolated soil organisms[118] show they are all degraded via similar pathways, the first steps of which involve oxygenation or hydroxylation of sulfur or nitrogen atoms, hydroxylation of aromatic rings and dealkylation of O- or N-alkyl groups.

Hydrolysis of the carbamate linkage would yield phenols which are amenable to further ring cleavage and ultimate reduction to small carbon fragments, e.g., 2,4-dichlorophenol (arising from soil organism metabolism of 2,4-D) degraded to succinic acid via intermediate chlorocatechols and chloromuconic acids.[119,120] Without hydrolysis, however, the carbamate linkage may persist, giving rise, initially, to a number of carbamate metabolites with toxicity (anti-cholinesterase) comparable to the parent compound. Accordingly, the O-phenyl carbamate pesticide wastes should be submitted to hydrolysis before disposal.

Our survey indicates that all the carbamate pesticides are rapidly hydrolyzed in strongly alkaline media: in most instances decomposition was complete within a few hours at room temperature. The National Agricultural Chemicals Association's recommendations[15] for the treatment of carbaryl manufacturing wastes can serve as a practical guideline for carbamate pesticide disposal: i.e., for each 5 lb of actual carbaryl, add 2 lb of flake caustic (sodium hydroxide) (this amount was stated to be a 50% excess over the minimum required) and allow about 24 hr for completion of the reaction. The first step of the degradation would be:

$$\text{Aryl-O-CO-NHR} + H_2O \xrightarrow{\text{NaOH}} \text{Aryl-OH} + [\text{HO-CO-NHR}]$$

The carbamic acid at the right would decompose to the amine and CO_2 in neutral solution, or to sodium carbonate in excess base. In excess base the phenol would be converted to the salt, i.e., NaO-Aryl.

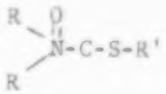
Phenolic decomposition products of some carbamate pesticides may, under some circumstances, persist in the environment and harm specific ecosystems. For example, the failure of molluscs to repopulate tidal flats treated with carbaryl,[121] was attributed to the formation of α-naphthol, which was shown experimentally to be 65% converted within 30 days in seawater to an unidentified insoluble toxin. Hence, the hydrolysis should be followed by soil burial of the products in disposal.

N-Aryl Carbamates: The low toxicity of the N-phenyl carbamate herbicides and of their demonstrated metabolites obviates any need for preliminary hydrolysis. Soil burial should suffice.

Initial hydrolytic decomposition to the corresponding aniline derivative is expected and has been observed with chloropropham (CIPC).[122] Degradation of aniline and 3-chloroaniline by soil or soil micro-organisms has been demonstrated but the metabolic path was not studied.[122,123] Ring hydroxylation has been proposed and the observation that 2-chloro-4-aminophenol is a metabolite of barban (via 3-chloroaniline) in wheat plants lends support to this suggestion.[124] If this is the case, then subsequent ring cleavage and degradation in a manner similar to that experienced by the chlorinated phenols is indicated. However, Swep would yield 3,4-dichloroaniline which can be converted in the soil to tetrachloroazobenzene and dichloroanilino-trichloroazobenzene.[125,126] Since some azobenzenes have shown carcinogenic activity, soil burial is not recommended for Swep or similar pesticides.

Thiocarbamates

A number of thiocarbamates of the type



(where R = alkyl and R' = various substituted alkyl or alkenyl) are used as herbicides. Included are:

Butylate
Cycloate
Diallate
S,S'[2-(Dimethylamino)trimethylene]-bisthiocarbamate, hydrochloride
Ethiolate
EPTC
Molinate
Pebulate
Triallate
Vernolate

The thiocarbamates are nonpersistent in the environment and disappear fairly rapidly (1-4 weeks) from the soil by microbial action, hydrolysis, vaporization, and leaching.[87,127,128a] The hydrolysis probably proceeds initially at the ester linkage to give the mercaptan and the dialkyl carbamic acid, which decomposes to the dialkyl amine and CO_2. The mercaptan and the amine are probably further degraded in the soil, respectively, to the alcohol (or sulfone) and to a mixture of CO_2, carboxylic acid, NH_3, urea, amino acid, and nitrate.

Secondary amines in significant concentrations in the environment are of concern because they are potential sources of nitrosoamines (via reactions with nitrites). However, studies of the decomposition of thiocarbamates in the soil have not detected nitrosoamines,[128b] and simple burial appears to be an acceptable disposal method for small quantities.

The thiocarbamates are combustible and all could be disposed by incineration. Simple burning might be an acceptable alternate method for those of low toxicity, such as cycloate and butylate.

The thiocarbamates are hydrolyzed[83] readily by excess alkali to the corresponding free amines and mercaptides as follows:

$$R_2N\text{-}CO\text{-}SR' + 3NaOH \longrightarrow R_2NH + NaSR' + Na_2CO_3 + H_2O$$

These products have little herbicidal activity and generally moderate acute toxicities to animals. The secondary amines would be generated immediately here (in contrast to hydrolysis in the soil) and would be objectionable in large quantity (see above). Hence, hydrolysis is not recommended, unless the entry of the amines into water supplies is carefully precluded.

EPTC: In addition to the hydrolysis reaction, EPTC has been reported[83] to be oxidatively cleaved to give the amine and ethane sulfonic acid.

Molinate: This cyclic thiocarbamate, $\overline{(CH_2)_6\text{-}N}\text{-}CO\text{-}SC_2H_5$, is stable to hydrolysis by water, but is hydrolyzed by H_2SO_4.[67]

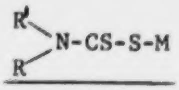
Dithiocarbamates

The dithiocarbamates are a series of related compounds and mixtures that are primarily fungicides or fungicide-nematocides. Most of the dithiocarbamate pesticides are metal salts of the methyl-, dimethyl- or ethylenebis-dithiocarbamic acids, but three of them are entirely organics.[83,129a] The principal dithiocarbamate products are:

CDEC
Dithane M-45®
Dithane S-31®
Ferbam
Maneb
Metham
Nabam
Niacide®
Polyethylene thiuram disulfide (PETD)
Polyram®
Thiram
Zineb
Ziram

The structural relationships of the various compounds and mixtures are shown below:

Dithiocarbamic Acid Derivatives

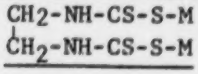


$$\begin{array}{l} R' \\ \quad \rangle N\text{-}CS\text{-}S\text{-}M \\ R \end{array}$$

	R	R'	M
Metham	H	Me	Na^+
PETD	H	$-CH_2-$	Polymer*
Ferbam	Me	Me	Fe^{+++}

* The structure of PETD is $[-CH_2\text{-}NH\text{-}CS\text{-}S\text{-}]_n$

Ethylenebis(dithiocarbamic acid) Derivatives



$$\begin{array}{l} CH_2\text{-}NH\text{-}CS\text{-}S\text{-}M \\ | \\ CH_2\text{-}NH\text{-}CS\text{-}S\text{-}M \end{array}$$

	M
Nabam	Na^+
Maneb	Mn^{++}
Zineb	Zn^{++}
Ammonium salt	NH_4

	R	R'	M
Ziram	Me	Me	Zn^{++}
Manganous salt	Me	Me	Mn^{++}
Potassium salt	Me	Me	K^{+}
Thiram	Me	Me	$-S-CS-NMe_2$
CDEC	Et	Et	$-CH_2-CCl=CH_2$

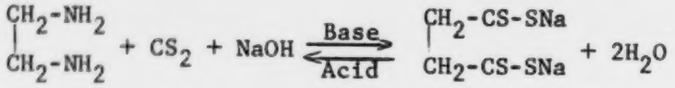
Mixtures

Dithane M-45®	Coordination complex of maneb and zinc salt
Dithane S-31®	Mixture of maneb-$NiSO_4$
Niacide®	Mixture of manganous dimethyl dithiocarbamate and mercaptobenzothiazole
Polyram®	Mixture of ammoniates of zineb, $[-CH_2NHCS_2H]_2$ and other sulfides

Maneb and its mixtures are the most widely used fungicides of the group. Some dithiocarbamates have only specialized uses in greenhouses or in care of ornamentals. Metham is a soil sterilant and CDEC is a herbicide.

The salts of the dithiocarbamic acids can be made by reaction of carbon disulfide under alkaline conditions with the appropriate alkyl amine or diamine and an appropriate source of the desired cation as shown below for an ammonium and sodium salt. (Salts of these two ions can be used as intermediates for preparation of the heavy metal salts.):

$$(CH_3)_2NH + CS_2 + NH_3 \underset{Acid}{\overset{Base}{\rightleftharpoons}} (CH_3)_2N-CS-SNH_4$$



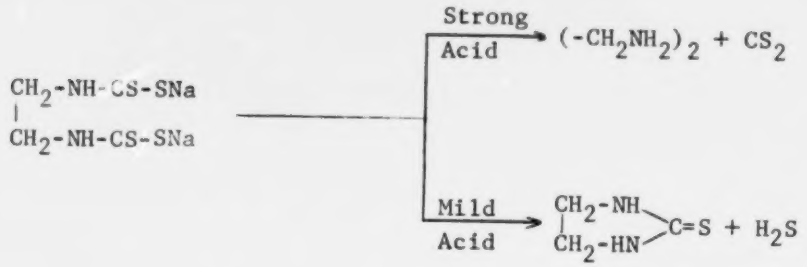
$$\begin{matrix} CH_2-NH_2 \\ | \\ CH_2-NH_2 \end{matrix} + CS_2 + NaOH \underset{Acid}{\overset{Base}{\rightleftharpoons}} \begin{matrix} CH_2-CS-SNa \\ | \\ CH_2-CS-SNa \end{matrix} + 2H_2O$$

These reactions are reversible and in the presence of strong acids (or in some cases merely moisture) CS_2 is regenerated along with the amine salt. For the mono N-alkyl compounds (metham and PETD), acid hydrolysis is suitable as a disposal method (with proper precautions for the flammable CS_2), but hydrolysis has drawbacks as a disposal method for other dithiocarbamates.

In the case of the dialkyldithiocarbamic acid derivatives, the secondary amines that would be generated are slowly degraded in the environment, but are potential sources (via reaction with nitrites) of carcinogenic nitrosoamines.

Hence acid hydrolysis, followed by discharge or burial of the products cannot be recommended unless the entry of the amines into water supplies is precluded.

The ethylenebis(dithiocarbamic acid) derivatives pose a different problem: under weakly acidic conditions they can decompose by an alternate route[80] to hydrogen sulfide and ethylene thiourea (ETU) as shown below:



The ETU is of much concern: it is a known carcinogen in mammals. Hence, all the dithiocarbamate pesticides which might form ETU (i.e., those derived from ethylene diamine) are also of much current concern.[129b] Acid hydrolysis therefore cannot be unequivocally recommended for these pesticides, unless precautions are taken to insure that ETU is not formed. Analytical methods for the acid hydrolysis of dithiocarbamates to CS_2 normally employ about 4 N acid and a ratio of acid to active ingredient of > 1000:1. Such a high ratio is not practical for disposal procedures, and information is needed on the lowest ratio that is still effective.

CDEC: The only dithiocarbamate used as a herbicide, CDEC is hydrolyzed very slowly in either very weak acid, pH 5, or very weak base, pH 8.[8] It is hydrolyzed rapidly in boiling caustic and is completely decomposed by strong oxidizing agents.[83]

Dithane S-31: The presence of nickel in this pesticide must be considered in disposal.

Ferbam: Ferbam is hydrolyzed by alkali and is unstable to moisture, lime and heat.[83] Ferbam can be incinerated.[8]

Maneb: Maneb is unstable to moisture and is hydrolyzed by acids and hot water.[8] It decomposes at about 100°C and may spontaneously decompose vigorously when stored in bulk.[83]

Metham: This compound reacts slowly with moisture to liberate the toxic gas, methyl isothiocyanate, the active agent in its use as a soil fungicide or sterilant. The metham is stabilized in concentrated aqueous solution, but liberates CH_3NCS upon dilution.[83] Hydrolysis to CS_2 should be an effective disposal method if excess acid (2- to 3-fold) is used.

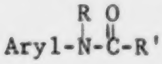
Thiram: Thiram can be dissolved in alcohol or other flammable solvent and burned in an incinerator with an afterburner and scrubber.[14]

Zineb: Zineb is unstable toward moisture, and acid hydrolysis yields CS_2.[8] Heating above 120°C causes decomposition to a carbonaceous product.[83]

Ziram: Ziram has a chelate structure and is more stable than most dithiocarbamates; it has good stability to moisture and is not decomposed readily by dilute acids. It is decomposed by strong acids and when heated with caustic alkalis, and can decompose violently upon prolonged heating at 170°-180°C.[83]

Anilides

The anilide group of pesticides are herbicides and fungicides of relatively low acute toxicities. Most, but not all are N-substituted, i.e., of the general structural form



$\mathrm{Aryl}-\overset{R}{\overset{|}{N}}-\overset{O}{\overset{\|}{C}}-R'$

where in a few cases R or R' are also cyclic or aromatic.

Alachlor
Butachlor
Carboxin
CDAA
Cypromid
Delachlor
Dicryl
2-Fluoro-N-methyl-N-(1-naphthyl)acetamide
Oxycarboxin
Propachlor
Propanil
Prynachlor
Solan®

The anilide pesticides can be readily decomposed by strong acid or base, but the decomposition products, either aniline or substituted anilines, are quite often more toxic than the starting material. In addition, studies with the chloroaniline-based herbicides have shown that this aromatic moiety gives rise to very persistant (5 to 10 years), complex residues in soil.[130] As a consequence, simple hydrolysis of these compounds cannot be recommended as a disposal method.

Incineration at 1800°F followed by treatment of the off-gas has been recommended.[109] Landfill burial has also been suggested but, in light of the generation of more toxic, persistent products, this mode of disposal does not seem desirable.

Recent work on the aerobic[131] and anerobic[132] microbial metabolism of various chlorinated aromatic insecticides may provide a valuable alternative to incineration for the disposal of compounds of this class. The use of photosensitized pesticide chemicals which will markedly alter the persistance of an otherwise refractory pesticide chemical[133] may also hold promise as a safe disposal method. Comments on specific anilides follows:

Alachlor: This compound is hydrolyzed under strongly acid or alkaline conditions,[8] to chloroacetic acid, methanol, formaldehyde and 2,6-diethylaniline. Incineration is recommended according to procedures described in the introduction to this section.

Butachlor: Butachlor is an analog of alachlor and should be disposed in the same manner.

Carboxin: Carboxin is resistant to mild oxidative and hydrolytic conditions. Alkaline hydrolysis yields the more toxic aniline.[8] Incineration appears to be the method of choice for disposal.

CDAA: Concentrated HCl at reflux temperature hydrolyzes the compound to chloroacetic acid and diallyl amine. The latter compound, a secondary amine, may be potentially hazardous: it may react with nitrites in the environment to form a nitrosoamine, a suspected carcinogen.

Cypromid: Acidic and basic media slowly hydrolyze cypromid. One product is 3,4-dichloroaniline which itself is toxic.[8] Under natural conditions complexing may extend the residual life of the latter in soil to several years.[130]

Dicryl: Dicryl can be hydrolyzed by alkali to the more toxic 3,4-dichloroaniline.[5] Therefore, hydrolysis cannot be recommended. Proper incineration would appear to be the method of choice.

2-Fluoro-N-methyl-N-(1-naphthyl)acetamide: Hydrolysis of this product yields the highly toxic fluoroacetic acid (LD_{50} 0.28 mg/kg).[70] Hydrolysis, therefore, should be avoided. (See p. 130 for disposal procedures for sodium fluoroacetate.) Disposal should be performed by qualified personnel only.

Oxycarboxin: Hydrolyzed by very acidic or basic conditions to yield the more toxic aniline.[8]

Propachlor: Alkaline hydrolysis would yield N-isopropylaniline.[8]

Propanil: Hydrolysis in acidic or basic media yields the more toxic substance, 3,4-dichloroaniline,[8] and is not recommended.

Prynachlor: This material is not sensitive to light or heat.[5] Hydrolysis in base yields the hazardous secondary amine, N-butynylaniline.

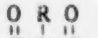
Solan®: Solan®, stable at room temperature, is hydrolyzed under basic conditions to give the substituted aniline.[8]

Imides and Hydrazides

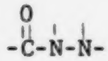
The compounds in this group include fungicides, herbicides, a plant growth regulator, a repellent and a rodenticide:

Captan
Cycloheximide
Difolatan®
Folpet
MGK 264®
MH®
Neopyamin®
Norbormide
Succinic acid-dimethylhydrazide

The common structural units in imides and hydrazides are shown on the left and right, respectively, below:



$-\overset{O}{\overset{\|}{C}}-\overset{R}{\overset{|}{N}}-\overset{O}{\overset{\|}{C}}-$



$-\overset{O}{\overset{\|}{C}}-\overset{|}{N}-\overset{|}{N}-$

Compounds in this category can generally be readily decomposed by treatment with strong base. The hydrolysis products, as a rule, do not present any special problems. Specific comments are:

Captan: Captan decomposes fairly readily in alkaline media (pH > 8). It is hydrolytically stable at neutral or acid pH but decomposes when heated alone at its melting point.[92]

Cycloheximide: Cycloheximide is stable in neutral or acidic solutions but decomposes rapidly in basic solution at room temperature. Chlordane for some unknown reason causes rapid loss of activity.[8]

Difolatan®: Difolatan® slowly hydrolyzed by water; rapidly hydrolyzed in alkaline solution. Decomposes slowly when heated at its melting point.[83]

Folpet: Folpet hydrolyzes slowly in water or in preparations not completely dry; stable when dry. It hydrolyzed rapidly at elevated temperatures or in alkaline media.[8]

MGK 264®: Chemically, MGK 264® is the most stable material of this class.[8] However, it should be readily hydrolyzed by base.

MH: This product is relatively stable to hydrolysis but decomposes in presence of strong acids and oxidizing agents.[8] Treatment with alkali hydroxides and amines results in the formation of water-soluble salts. Salts of alkaline-earth and heavy metals are practically insoluble in water.[83] Burning with polyethylene has been reported to result in > 99% decomposition.[49] Literature summaries for 1949-1963 are available.[134]

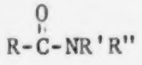
Neopyamin®: Neopyamin® is stable under normal conditions.[8] Alkaline hydrolysis should readily decompose the material.

Norbormide: Norbormide is a very selective rodenticide; it is lethal to all members of the genus *Rattus* but is relatively nonlethal to other animals. It is stable at room temperature when dry; hydrolyzed by alkali.[8]

Succinic Acid-2,2-dimethylhydrazide: This product is stable at 50°C for 5 months, stable in water for over 2 months, and stable in solution at 80°F for 21 days. It is rapidly hydrolyzed in boiling dilute HCl and boiling 50% sodium hydroxide solutions.[92]

Amides

The compounds in this class are herbicides, plant growth regulators and repellants. Both aliphatic and aromatic amides are included and the amide is normally N-substituted, i.e., of the form



$$R\text{-}\overset{\overset{\displaystyle O}{\|}}{C}\text{-}NR'R''$$

where R' may be hydrogen.

Benzadox
Carbetamide
2-[(4-Chloro-*o*-tolyl)oxy]-N-methoxyacetamide
Diethyltoluamide
Diphenamid
Naphthalene acetamide

Very little information relative to disposal methods for compounds listed in this category is noted in the literature. In general, the compounds are hydrolyzed when subjected to acidic or basic conditions at elevated temperatures. The stability of some members of the class is reflected in the long term persistence after applications. In the case of diphenamid, phytotoxic levels were noted 10 to 11 months after application.[135]

Benzadox: This compound should be readily hydrolyzed in strong base to yield harmless products.

Carbetamide: This product, which contains both an amide and a carbamate function, is stable under normal storage conditions. It is hydrolyzed in strong acid at elevated temperatures.[8] The compound can also be hydrolyzed under strong basic conditions, but both acidic and basic hydrolysis yields aniline which is much more toxic than the starting material.

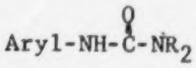
Diphenamid: The product is moderately stable to heat and light. It is phytotoxic 10 to 11 months after application.[135]

Ureas and Uracils

The compounds in this group--all selective herbicides of low acute toxicity--are as follows:

Bromacil
Chlorbromuron
Chloroxuron
DCU
Diuron
Fenuron
Fenuron TCA
Fluometuron
Isocil
Lenacil
Linuron
Metobromuron
Monolinuron
Monuron
Monuron TCA
Neburon
Norea
Siduron
Sodium 5-chloro-2-(4-chloro-2-(3-(3,4-dichlorophenyl)ureido)phenoxy)benzenesulfonate
Terbacil

The Ureas: The urea herbicides of interest have the general structural form



$$\text{Aryl-NH-}\overset{O}{\overset{\|}{C}}\text{-NR}_2$$

where R is alkyl or alkoxy groups. They can be decomposed by heating with strong base or acid. In most cases, however, the resulting products--usually aniline, substituted anilines and/or dimethylamine--are more toxic than the starting material. As a consequence, disposal by simple hydrolysis is not recommended. Proper incineration may be the method of choice with this class of compounds.

Chlorbromuron: This compound can be hydrolyzed by either acid or base[8] but this method is not recommended for disposal.

Chloroxuron: Acid or alkaline hydrolysis yields 4(4-chlorophenoxy)aniline and dimethylamine. Continued heating in boiling water yields the symetrically substituted urea, N,N'(4-chlorophenoxy)phenylurea.[136]

DCU: This compound is stable to dilute acids but is rapidly decomposed on heating with alkali.

Diuron: Diuron, stable under normal conditions, decomposes on heating to 180° to 190°C giving dimethylamine and 3,4-dichlorophenylisocyanate. Treatment at elevated temperatures by acid or base yields dimethylamine and 3,4-dichloroaniline.[83] Hydrolysis is not recommended as a disposal procedure because of the generation of the toxic products, 3,4-dichloroaniline and dimethylamine.

Fenuron: Fenuron decomposes in boiling strong bases or mineral acids. The products, however (aniline and dimethylamine), are both toxic, thus precluding hydrolysis as a disposal method.[83]

Fenuron TCA: This compound, a salt of fenuron, presents similar disposal problems.[5,8] The chlorine in TCA must be considered in incineration.

Fluometuron: The chemical properties of this compound are similar to other urea derivatives; it is decomposed by strong base or acid at elevated temperature. However, this method is not recommended due to generation of toxic products.

Linuron: Linuron can be hydrolyzed in alkaline and especially in acidic media.[83] However, this procedure is not recommended due to generation of more toxic products.

Metobromuran (Patoran): The chemical properties of this compound are similar to linuron.[83]

Monuron: The chemical properties of this compound are similar to diuron.

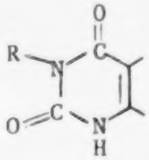
Monuron TCA: This compound is a salt of monuron; it should be treated in a fashion similar to that of diuron and fenuron TCA.

Neburon: The chemical properties of this compound are similar to other urea derivatives.[83]

Norea: Norea can be hydrolyzed at elevated temperature by acids or bases. This procedure is not recommended due to generation of the toxic material, dimethylamine.

Siduron: Siduron is slowly decomposed by acids or bases[8] liberating aniline. This procedure is not recommended for disposal.

The Uracils: The uracil herbicides of interest have the structural feature



They can generally be degraded by the action of concentrated acid. However, the reaction is slow and the herbicide is only partially decomposed.[64] Incineration would most likely provide the quickest and surest means of disposal.

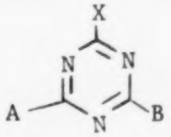
Bromacil: Bromacil is stable in water and aqueous bases. It is also stable at temperatures up to the melting point. It decomposes slowly in strong acid.[137]

Isocil: Isocil decomposes slowly in strong acids or bases.[2,8]

Lenacil: This compound is decomposed by the action of strong alkali.[83]

Triazines

The derivatives of s-triazine form an important class of herbicides. Atrazine is by far the most widely used of all herbicides today. The general structure is:



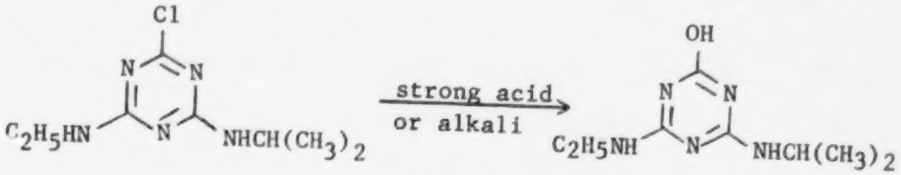
where A and B are normally amine groups and X a less basic group as shown below. (Note: Numbering of the substituents is in alphabetical order, e.g., 2-chloro but 6-methoxy with i-PrNH-groups at A and B.)

	A	B	X
Ametryne®	EtNH-	i-PrNH-	$-SCH_3$
Atratrone	EtNH-	i-PrNH-	$-OCH_3$
Atrazine	EtNH-	i-PrNH-	-Cl
Bladex®	EtNH-	$(CH_3)_2C(CN)NH-$	-Cl
Chlorazine	Et_2N-	Et_2N-	-Cl

	A	B	X
Cyprazine	$\overline{\mathrm{CH_2CH_2CH}}\mathrm{N}$-	$(CH_3)_2$CHNH-	-Cl
Dyrene®	ClC_6H_4NH-	Cl-	-Cl
Igran 80W®	EtNH-	$(CH_3)_3$CNH-	$-SCH_3$
MPMT	$CH_3O(CH_2)_3$NH-	$CH_3O(CH_2)_3$NH-	$-SCH_3$
Prometone	i-PrNH-	i-PrNH-	$-OCH_3$
Prometryne	i-PrNH-	i-PrNH-	$-SCH_3$
Propazine	i-PrNH-	i-PrNH-	-Cl
Simazine	EtNH-	EtNH-	-Cl
Trietazine	EtNH-	EtNH-	-Cl

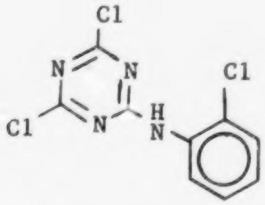
The compounds are generally quite stable. The heterocyclic triazine ring system is very stable and is not cleaved except under drastic conditions. The amino groups are generally unreactive. However, the chloro-, methylthio-, or methoxy-functions can be hydrolyzed to give the corresponding hydroxy compound as shown below for atrazine.

Atrazine: Atrazine is hydrolyzed by either acid or base as shown:



The hydroxy compounds are generally herbicidally inactive,[8] but their complete environmental effects are uncertain. However, the method appears suitable for limited use and quantities of triazine with the exception of Dyrene®.

Dyrene®: The structure of this triazine is sufficiently different that special comment is required.



While it is readily hydrolyzed by treatment with sodium hydroxide at elevated temperatures, o-chloroaniline may be formed as a product, and therefore this method is not recommended for disposal.

Combustion of Triazines: Burning appears to offer the best general means of disposal of triazines. Atrazine underwent > 99% decomposition when burned in a polyethylene bag,[41] and combustion with a hydrocarbon fuel would appear to be a generally suitable method for small quantities. Combustion of larger quantities would probably require the use of a caustic wet scrubber to remove nitrogen oxides and HCl from the product gases.

Amines, Heterocyclic (without sulfur)

The pesticides in this group are mostly herbicides, plant growth regulators or fungicides of low acute toxicity. Exceptions are the extremely toxic nicotine, a natural product insecticide, and an acaricide of moderate toxicity. A repellent is also included in the list as shown:

Amitrole
Ancymidol
Dichlozoline
Dimethirimol
2,6-Dimethyl-3,5-dichloro-4-pyridinol
Ethirimol
Ethoxyquin
Indolebutyric acid
Lovozal®
Methazole
MGK Repellent 326®
Nicotine
Nitrapyrin
Picloram
Pipron®
Pyrazon
8-Quinolinol sulfate
Triarimol

There is no general method for the chemical detoxification of compounds in this group.

Some of the products can be safely buried; the requirements are: (1) the product should be of relatively low toxicity, (2) evidence should be available that it does not accumulate in soil or persist in the environment, (3) it should be known to be nonhazardous to wildlife.

The Manufacturing Chemists Association suggests incineration for compounds of this kind. For aromatic and aliphatic amines, the following procedures[14] are suggested:

> "Pour or sift onto a thick layer of sand and soda ash mixture (90-10). Mix and shovel into a heavy paper box with much paper packing. Burn in incinerator. Fire may be augmented by adding excelsior and scrap wood. Stay on upwind side.
>
> "Waste may be dissolved in flammable solvent (alcohols, benzene, etc.) and sprayed into fire box of an incinerator with afterburner and scrubber."

For halogenated aromatic amines the procedures[14] are somewhat similar:

> "Pour or sift onto sodium bicarbonate or a sand-soda ash mixture (90-10). Mix and package in heavy paper cartons with plenty of paper packing to serve as fuel. Burn in an incinerator. Fire may be augmented with scrap wood.
> "The packages above may be burned more effectively in an incinerator with afterburner and scrubber (alkaline).
> "The waste may be mixed with a flammable solvent (alcohol, benzene, etc.) and sprayed into the fire chamber of an incinerator with afterburners and scrubber."

If the products contain fluorine, slaked lime should be added to the mixture prior to incineration.[14]

Amitrole: This white solid herbicide has low acute toxicity to mammals (LD_{50} = 14,700), but is a goitrogen at high concentrations.[5] Its toxicity to fish is also low: 1470 ppm is the "biologically safe concentration" for bluegill perch.[68] It is resistant to hydrolysis and the action of oxidizing agents.[83] Burning the compound with polyethylene is reported to result in > 99% decomposition.[41]

Ethoxyquin: Ethoxyquin, a dark liquid plant growth regulator is not phytotoxic at recommended application rates.[68]

Indolebutyric acid: This crystalline plant growth regulator has "low" acute oral, chronic oral and dermal toxicity. It is reported to have no hazard to wildlife and it does not accumulate in the soil.[68]

Lovozal®: Lovozal® is a green-yellow powder which is used experimentally as an acaricide. The compound contains a dichloro aromatic structure which would cause environmental persistence for fragments of the molecule containing their structure. The compound also contains fluorine. The presence of these two halogens will cause air pollution problems if the compound is incinerated. This hazard can be minimized by: (1) using an incinerator with an afterburner and an alkaline scrubber, or (2) mixing the compound with a small amount of slaked lime prior to burning.

MGK Repellent 326®: This amber liquid is an insect repellent for flies. The product has low oral (LD_{50} = 6,230 ± 1,000) and dermal (9.4 ml/kg toxicity).

Nicotine: Nicotine, an alkaloid obtained from the tobacco family of plants, is a highly toxic (LD_{50} = 55) insecticide. It is frequently marketed as the sulfate. The Manufacturing Chemists Association has suggested incineration as a method of disposal.[14] Procedures are described at the beginning of this section. Nicotine is reported to be hazardous to wildlife.

Nitrapyrin: The manufacturer of this nitrification inhibitor suggests that unwanted quantities can be disposed of by burial in a sanitary landfill.

Picloram: This chlorinated brush killer is usually formulated with 2,4-D and the disposal problems are similar. Picloram is reported to have low toxicity to wildlife and "no problem exists when used according to label directions." The product is highly phytotoxic, accumulates in the soil, and is persistent.[68]

Incineration at 1000°C for 2 sec is required[109] for thermal decomposition. Alternatively, the free acid can be precipitated from its solutions by addition of a mineral acid. The concentrated acid can then be incinerated and the dilute residual solution disposed in an area where several years persistence in the soil can be tolerated.

Pipron®: Pipron® is a fungicide which will kill fish at 1 to 10 ppm in water. The presence in the molecule of a dichloroaromatic structure indicates; (1) some environmental persistence of at least this fragment of the molecule, and (2) air pollution hazards due to the formulation of HCl for incineration (see discussion at the beginning of this section).

Pyrazon: This crystalline herbicide is stable in acid media.[68] It persists in sandy loam about 20 weeks and is decomposed to a compound (4-amino-5-chloropyradaz-6-one) which is nonphytotoxic.[8]

8-Quinolinol: The disposal procedures for aromatic amines (see discussion at the beginning of this section) have been specifically recommended for this fungicide.[14]

Amines, Heterocyclic (sulfur-containing)

This group of pesticides consists of fungicides, a herbicide and two insecticides, and includes the following compounds:

Bentazon
5-Chloro-2-mercaptobenzothiazole
Cyanomethylthiobenzothiazole
Dazomet
Eradex
2-Mercaptobenzothiazole
Milneb
Morestan®
Phenothiazine
Terrazole®
Thiabendazole
4,5,7-Trichlorobenzthiadiazole-2,1,3

The toxicities of these compounds are generally low or moderate. Disposal procedures for these pesticides are similar to those suggested in the previous section, "Amines, Heterocyclic."

Dazomet: Dazomet, a crystalline fungicide, structurally related to the dithiocarbamates, decomposes upon heating at 100°C (its melting point) to form methylisothiocyanate and dimethylthiourea.[83] The decomposition rate is accelerated by moisture. Acid hydrolysis results in the formation of carbon disulfide[8] (see carbon disulfide).

Eradex®: This brown solid miticide and fungicide is stable to 200°C and is resistant to hydrolysis. It is a skin irritant.[68] It is susceptible to atmospheric oxidation, forming sulfur oxides which have biological activity.

2-Mercaptobenzothiazole: This white solid is an important rubber accelerator but is also used as a fungicide. It is used on animals and in mixtures with dithiocarbamate fungicides. Its pesticidal formulations are often in the form of the zinc or monoethanolamine salts.

Morestan: Morestan, a yellow solid is an insecticide, miticide and fungicide and is similar in chemical action to Eradex®, although it is more stable to oxidation.[8] It is subject to alkaline hydrolysis. The compound should not be allowed to contaminate streams, lakes, or ponds. Some phytotoxicity has been observed with certain varieties of roses.[68]

Phenothiazine: This yellow solid insecticide is oxidized in the presence of air and light to products which are reported to be fungicidal.[67] The oxidation products sensitize skin to irritation by light, frequently causing dermatosis.[68]

Thiabendazole: Thiabendazole is a fungicide which is reported to be stable in both acid and alkaline solutions.[138]

Terrazole: Terrazole, a liquid fungicide, is thermally stable to at least 165°C. It is not degraded by UV radiation or oxygen. It is hydrolyzed on contact with alkaline media.[67] The compound contains chlorine and is usually formulated with pentachloronitrobenzene (see nitro compounds). Therefore, incineration will produce an added air pollution hazard because of the production of HCl. (See disposal procedures for chlorinated hydrocarbons.)

4,5,7-Trichlorobenzthiadizole-2,1,3: This solid herbicide is stable at room temperature to dilute alkali and mineral acid.[8] The residual activity of this product in soils lasts approximately 6 weeks.[5] Incineration of this compound produces the same air pollution hazard as chlorinated hydrocarbons.

Nitro Compounds

This group of pesticides, primarily herbicides and fungicides, shows wide variations in toxicity, environmental persistence, and chemical and thermal stability. The list is given below.

Bayluscide
Benefin
Binapacryl
Chloropicrin
DCNA
2,5-Dichloro-3-nitrobenzoic acid
Dinitrocyclohexylphenol
Dinobuton
Dinoseb
Dinoseb acetate
DNOC
Ethide®
Fluorodifen
Isopropalin
Karathane®
Lanstan®
Nitralin
Nitrobenzene
Nitrofen
Oryzalin
N-Phenyl-2-nitropropylpiperidine
3-Trifluoromethyl-4-nitrophenol
Trifluralin
Zoalene
PCNB
Tetrachloronitrobenzene

There is no general method of chemical detoxification of these materials. Perhaps the best disposal methods are incineration and burial.

Almost all of the compounds are decomposed at the relatively moderate temperatures achieved by open burning. However, special precautions and special equipment are required to prevent air pollution by the halogenated nitro compounds. The disposal of large quantities of these products requires the use of an incinerator with an afterburner and an alkaline scrubber. Highly toxic compounds must also be incinerated carefully; the use of an incinerator with an afterburner is recommended. Concentrated solutions should be diluted with flammable solvent prior to incineration.

Compounds which are known to be (1) nonpersistent and (2) relatively nontoxic to mammals, plants and fish can be buried, especially if only small quantities are involved.

Bayluscide®: Bayluscide® is used in the control of snails and lampreys. It is reported to be highly stable to heat.[67]

Benefin: This orange-yellow liquid herbicide is relatively nontoxic (LD_{50} = 10,000). It is reported to be susceptible to decomposition by ultraviolet radiation.

Binapacryl: Binapacryl, a toxic miticide, is decomposed by strong acids or bases to the very toxic 2-sec -butyl-4,6-dinitrophenol (dinoseb, see below) and 3-methyl-2-butenoic acid.[92] The product is slowly decomposed by UV radiation. High concentrations may be phytotoxic.[8] It is not subject to oxidation.[114]

Chloropicrin: This intensely irritating liquid fumigant is lethal (LD_{50} = 0.8) to most wildlife at very low concentration when confined.[67] It is also toxic to plants when injected into soil and in low concentrations in air it may decrease germination.[67] It reacts readily with alcoholic sodium sulfite solutions to produce methanetrisulfonic acid (which is relatively nonvolatile and less harmful). This reaction has been recommended for treating spills and cleaning equipment. Although not specifically suggested as a decontamination procedure, the rapid reaction of chloropicrin with ammonia[139] to produce guanidine (LD_{50} = 500) could be used for detoxification.

The Manufacturing Chemists Association[14] suggests two procedures for disposal of chloropicrin:

> "Pour or sift over soda ash. Mix and wash slowly into large tank. Neutralize and pass to sewer with excess water."

"Absorb on vermiculite. Mix and shovel into paper boxes.
Drop into incinerator with afterburner and scrubber."

DCNA: DCNA, a relatively nontoxic, solid fungicide, is stable to heat and light,[67] and to hydrolysis and oxidation.[8] It reacts with strong alkali to produce a color suitable for quantitative analysis, but the value of this reaction as a detoxification procedure is uncertain.

2,5-Dichloro-3-nitrobenzoic acid (and salts): The disposal of this herbicide presents problems similar to the closely related, dichloroaromatic compound, chloramben. See Organo-Chlorine Pesticides, Dihaloaromatic Compounds.

Dinitrocyclohexylphenol: This miticide and insecticide is no longer of commercial interest.[86] The phytotoxicity of the compound is "very great".[67]

Dinobuton: Dinobuton, an experimental miticide and fungicide, is easily converted by hydrolysis into the corresponding dinitrophenol[18] (dinoseb, see below), which is even more toxic than the original product.

Dinoseb: This herbicide is highly toxic to mammals and fish.

DNOC: DNOC or dinitroorthocresol is very hazardous to the environment because of its high toxicity to mammals, fish and plants. Lethal dosages may be absorbed through the skin, although local irritation is usually slight.[67]

Ethide®: Ethide®, a liquid fumigant, is chemically similar to chloropicrin (see above, this section). Detoxification and disposal procedures are the same as for chloropicrin.

Fluorodifen: Fluorodifen, a solid herbicide, is relatively nontoxic (LD_{50} = 15,000). It does contain fluorine, and therefore incineration presents the increased hazard of HF in the off-gases. The Manufacturing Chemists Association suggests that, prior to incineration, fluorine-containing compounds should be mixed with slaked lime plus vermiculite, sodium carbonate or sand-soda ash mixture (90-10).[14]

Karathane®: This fungicide and miticide is chemically similar to the other dinitrophenol derivatives discussed previously (binapacryl, DNOC, dinoseb, dinobuton, and dinitrocyclohexylphenol). Hydrolysis produces the corresponding dinitrophenol derivative which is more toxic than the original product.

Lanstan®: Lanstan®, a soil fungicide, is chemically similar to chloropicrin and Ethide® and disposal would be similar.

Nitralin: Nitralin, a solid herbicide, has a half-life in the soil of 30 to 50 days.[67] It decomposes vigorously and explosively at 225°C and is flammable.[8] It is evidently unstable toward strong bases.[8]

Nitrobenzene: This pale yellow liquid was formerly used in sprays for insects in poultry houses. It is highly toxic (LD_{50} = 10); as little as seven drops has killed humans and the compound is readily absorbed through skin.

Nitrofen: Nitrofen, a solid herbicide, is relatively nontoxic (LD_{50} = 3,050) and is nonirritating to the skin.[67] It darkens on exposure to light.[8] The dichloro aromatic constituent of the molecule precludes rapid degradation in the environment.

Oryzalin: This yellow-orange solid herbicide is relatively nontoxic (LD_{50} = 10,000) and disappears rapidly when mixed with soil maintained under flooded conditions. It presents no "undue hazard" to fish.[5]

PCNB: Pentachloronitrobenzene is a solid soil fungicide and is relatively nontoxic (LD_{50} = 12,000) but may cause skin irritation on repeated contact.[67] It has been observed[49] that the product decomposes readily when burned with polyethylene. The compound is highly stable in soil, as would be expected on the basis of the polychlorinated aromatic structure.

Tetrachloronitrobenzene: The disposal of this crystalline solid fungicide presents difficulties similar to PCNB. (See above.)

3-Trifluoromethyl-4-nitrophenol: This yellow solid is used as a lampreycide: lamprey larvae are controlled by applications of 0.4 to 0.5 ppm, but fish are injured at concentrations above 10 ppm. Because of the fluorine content of this product, incineration precautions should be taken, as suggested for fluorodifen (see above, this section).

Trifluralin: Trifluralin is a widely used herbicide and is relatively nontoxic (LD_{50} = > 10,000). It has an intense yellow-orange color and is detectable in water at low concentrations.[67] The compound is susceptible to photochemical decomposition.[8] If incinerated, the same precautions should be taken as recommended for fluorodifen (see above).

Zoalene: Zoalene, a light tan powder, is used as an anticoccidial feed additive for chickens.

Quaternary Ammonium Compounds

Cycocel®
Diphenylammonium propionate
Diquat
Glyodin®
Paraquat
Penar®

Cycocel®: Cycocel®, a crystalline, water-soluble solid, melts at 245°C with decomposition. Incineration would be a highly effective disposal method. Heating the product with strong aqueous alkaline would result in decomposition with the evolution of trimethyl amine and other gaseous products.

Diquat: Diquat is a yellow crystalline herbicide. It is inactivated by inert clay or by anionic surfactants.[8] Therefore, an effective and environmentally safe disposal method would be to mix the product with ordinary household detergent and bury the mixture in clay soil.

Glyodin®: This light orange solid fungicide is readily decomposed by alkali to produce relatively harmless products (2-aminoethyl stearamide).[140] The fungicide has presented no observable hazards to wild life although it may be injurious to some plants, e.g., the solanaceous family.[67]

Paraquat: Paraquat, a white crystalline herbicide, is rapidly inactivated in soil.[67] It is also inactivated by anionic surfactants. Therefore an effective and environmentally safe disposal method would be to mix the product with ordinary household detergent and bury the mixture in clay soil.

Penar®: The manufacturer of this plant growth regulator has suggested burial as a disposal method.[141]

Other Nitrogen-Containing Compounds

A number of other nitrogen-containing compounds of diverse structures and properties are used as pesticides. Included are amines, anilines, amidines, azos, nitriles and guanidines as listed below:

Acrylonitrile
2-Aminobutane
Antu®
Azobenzene
Bentomate
2,6-Bis(dimethylaminomethyl)cyclohexanone
Chlordimeform
Dexon®
Diphenatrile
Diphenylamine
Dodine
Ioxynil
Methyl-2,3,5,6-tetrachloro-N-methylterephthalamate
Naptalam
Polyacrylonitrile, hydrolyzed, sodium salt
Thiophanate
Thiophanate methyl
Tridemorph
Vorlex®

The disposal problems, in general, appear to be similar to those of the heterocyclic amines and the anilides. Specific comments on disposal aspects follow.

Acrylonitrile: Acrylonitrile is a very toxic liquid fumigant. It is formulated as mixtures with carbon tetrachloride. A procedure which would safely and effectively cause the combustion of carbon tetrachloride would also provide a disposal method for the acrylonitrile mixture (see carbon tetrachloride, p. 113).

Antu®: Antu®, a solid rodenticide, is stable in light and air.[8]

Azobenzene: Azobenzene is an orange-red miticide and is chemically stable.[8]

Chlordimeform: This solid miticide is hydrolyzed in alkaline, neutral or acidic media, first to N-formylchlorotoluidine and then to 4-chlorotoluidine (a less toxic product). The hydrolysis proceeds slowly in acidic media. It is stable at 50°C for 70 hr, but decomposes[8] at its melting point of 225-227°C. It is reported to decompose in fire and may give off poisonous fumes.[142]

Dexon®: Dexon® is a highly toxic (LD_{50} = 60), yellow-brown, solid fungicide. It is unstable in alkaline media and is rapidly decomposed in the presence of light. Dilute aqueous solutions are completely decolorized in 30 min or less when exposed to ordinary light--concentrated solutions decompose more slowly.

Diphenylamine: The Manufacturing Chemists Association has suggested incineration for the disposal of this solid aromatic amine fungicide.[14]

Diphenatrile: This yellow solid herbicide is formulated as mixtures on vermiculite or in fertilizers (11.5%).

Dodine: Dodine, a solid fungicide, is stable under moderately alkaline conditions, but is hydrolyzed by strong alkali, liberating dodecylamine.[83] It is incompatible with lime[67] and anionic surfactants.[8]

Ioxynil: Ioxynil, a white, crystalline herbicide, is chemically stable,[8] but produces little or no residual activity in soil.[67] It contains substantial quantities of iodine which presents the same incineration hazards as chlorinated pesticides.

Methyl-2,3,5,6-tetrachloro-N-methyl terephthalamate: This white crystalline herbicide decomposes at 250°C. It is stable under prolonged exposure to acids at normal temperatures but slowly hydrolyzes under strongly alkaline conditions. It is stable to intense UV radiation.[5] The highly-halogenated aromatic structure indicates that this portion of the molecule would persist n the environment (for incineration precautions for halogenated aromatic ompounds).

aptalam: Naptalam is a solid herbicide which is relatively nontoxic (LD_{50} = ,200) to warm blooded animals.[67] The product is incompatible with strong cids and strong alkalies which hydrolyze the product to α-naphthylamine, hich is much more toxic than the original product, and phthalic acid (or ts salt).

orlex®: The principal active ingredient in this crystalline soil fumigant s methyl isothiocyanate, but the formulation commonly contains chlorinated $_3$ hydrocarbons and a chloropicrin. It is toxic (LD_{50} = 300), a lachrymator, nd is phytotoxic.[67] It decomposes in soil in about 3 weeks (at 55 to 65°F).[8] or disposal procedures for these products see dichloropropane and dichloro-ropene.

HALOGEN-CONTAINING PESTICIDES

The chlorinated organic pesticides have a wide range of properties and uses, and present some very difficult disposal problems. This classification contains some of the most environmentally persistent pesticides (excluding the permanently persistent heavy metals), such as benzene hexachloride, dieldrin and DDT, but it contains also many compounds of low persistence, so that the term "chlorinated hydrocarbon" should not be used carelessly. In addition to the compounds covered in this classification, a great many of the phosphorus- and nitrogen-containing pesticides contain one or more chlorine atoms per molecule.

DDT

DDT is the most widely known of all pesticides and had been accepted for use throughout the world. Recently, however, it has come under great pressure because of its environmental persistence and suspected environmental hazards; its use has been reduced or banned in many communities and states, and cancellation of remaining uses in the United States is under consideration. (One should note that recent developments related to DDT analysis in environmental samples makes suspect the accuracy of much of the previous data on which conclusions have been drawn.) In many communities, collection programs have been organized for unused quantities of DDT.

DDT is chemically and biologically quite stable and its degradation poses a serious challenge. Specific methods which have been studied are discussed following:

Reaction with Base

At the time of its discovery in 1874 DDT was reported to undergo a dehydrochlorination reaction in strongly basic solution, i.e., caustic alkali in alcohol,[143] to give a product now known as DDE.

$$(ClC_6H_4)_2CH\text{-}CCl_3 \xrightarrow[\text{Alcohol}]{\text{Base}} (ClC_6H_4)_2C = CCl_2 + HCl\cdot\text{Base}$$

In the late 1940's the dehydrochlorination was shown to be complete in 30 to 60 min at room temperature in 0.1N alkali solution[144] and to occur also with organic bases such as amines.[145] The importance of a mutual solvent for the water-insoluble DDT for the dehydrochlorination by base and also by certain catalysts such as iron, chromium, copper, manganese, and aluminum compounds has been noted.[145,146]

The dehydrochlorination reaction[147] (frequently referred to incorrectly as a hydrolysis) continues to be mentioned as a degradation method,[15,55] but it is not suitable as a disposal method: although the DDE is insecticidally nearly inert,[146] it is persistent in the environment and is suspected of being biomagnified and causing undesirable effects in fish and fowl. It is, in fact, one of the intermediates in the degradation of DDT in the environment. The DDE can be partially dechlorinated[147] only under the most strenuous caustic conditions: at 150 to 160°C in ethanolic KOH $(ClC_6H_4)_2CHCOOH$ formed, and at 145°C with sodium methoxide $(ClC_6H_4)_2CH_2$ is formed. Similar products were obtained[147] directly from DDT by refluxing with KOH in ethylene glycol or by heating 80 hr with alcoholic KOH. This method is obviously not suited for use by the layman.

Similarly, DDE can be partially dechlorinated under extremely strong acid conditions (e.g., CrO_3 in hot glacial acetic or hot fuming nitric) to $(ClC_6H_4)_2C{=}O$ (or its nitro derivatives).[147] Again, the reaction is not useful as a disposal procedure.

Oxidation

DDT is quite resistant to oxidation and is not oxidized by chromic oxide in glacial acetic acid or by nitric acid, although the latter nitrates the aromatic rings.[146,147] Similarly, attempted oxidation by permanganate, persulfate, chlorine or hypochorite has given poor results.[55] Chlorination with Cl_2/PCl_3 in CCl_4 at reflux gave $(ClC_6H_4)_2CCl\text{-}CCl_3$[147] and one would suspect that stronger chlorination might give polychlorinates which would be more persistent than DDT itself.

Reduction

The reduction of DDT by active metals has been known for several years. For example, a mixture of zinc granules, HCl in aqueous ethanol gives[147] a mixture of partially dechlorinated products: $(ClC_6H_4)_2CH\text{-}CH_3$, $(ClC_6H_4)_2\text{-}CH\text{-}CHCl_2$, and $ClC_6H_4\text{-}CH{=}CH\text{-}C_6H_4Cl$. Sodium, on the other hand, completely dechlorinates DDT in alcoholic solution, a reaction frequently used as an analytical method for total chlorine in chlorinated organics.[92] Recently this reaction has been conducted with sodium or lithium in liquid ammonia,[62] but this is not a practical disposal procedure. However, the reduction of DDT to $(ClC_6H_4)_2CH\text{-}CH_3$ (DDEt) by the use of zinc dust, dilute acetic acid and acetone at 25°C has been reported and copper salts were found to catalyze the reduction.[48] This system could have some practical application, but it has been used on only gram quantities of DDT to date,[48] and therefore cannot be confidently recommended for general use on large amounts. The DDEt is less toxic than DDT or DDE but information on its behavior in the environment is lacking.

Other metals were also evaluated in these studies,[48] but were either less effective (iron, aluminum, magnesium, manganese) than the zinc or ineffective (copper). Inorganic reductants (Na_2SO_3, $Na_2S_2O_3$, NaI and $CrCl_3$) in acetic acid-acetone media were also less effective than zinc and in addition gave DDE as the major product. Similar results were obtained with $Na_2S_2O_4$ or $Zn_2S_2O_4$ as reductants in caustic alcohol media, or with Na_2S in alcohol while lithium borohydride was ineffective.

Pyrolysis-Combustion-Incineration

DDT is stable up to about 300°C, and at this temperature at least 10% of the DDT distilled without decomposition.[49] Only 5% of the DDT distilled when the pyrolysis was conducted in the presence of mineral oil and only 1% with potassium chlorate, but unfortunately the decomposition products, some of which appear to be chlorinated hydrocarbons, were not identified.[49] Molten DDT is subject to catalytic dehydrochlorination by impurities such as certain metals.[146]

DDT does not burn readily because of the high chlorine content (and has in fact been used pesticidally in a burning fumigant mixture) but it can be combusted when diluted in a fuel oil. Recent studies have concluded that burning wood, cardboard, paper or plastics such as polyethylene are satisfactory for most pesticides.[49] The efficiency for a chlorinated hydrocarbon such as DDT is probably very dependent on having a sufficiently large fuel-to-pesticide ratio as well as on avoiding high local concentrations of pesticide. The method has not been demonstrated on a sizable scale and insufficient data are available to describe a general procedure in detail.

Incineration on the other hand has been successfully used on a large scale for several years[53] and huge incinerator equipment with scrubbers to catch HCl, a combustion product, are in use at several facilities such as Hooker Chemical, Dow Chemical and other producers of chlorinated hydrocarbon products. One incinerator operates at 900° to 1400°C with air and steam added which precludes formation of Cl_2.[53] A few companies also construct incinerator-scrubber combinations of smaller size--e.g., a system built by Garver-Davis, Inc., of Cleveland, Ohio, for the Canadian government can handle 200 to 500 lb DDT/day as a kerosene solution.[58,148]

Lists of manufacturers of incinerators, flue-gas equipment and flue-gas scrubbers have been compiled[42] but no indication of reliability of the equipment for pesticide disposal was made.

Biological Methods

The biological degradation of DDT has received considerable interest, including numerous studies of the microbiological degradation under anaerobic and aerobic conditions. The consensus appears to be that anaerobic degradation[149-153] is faster, but the most common product DDD, $(ClC_6H_4)_2CHCHCl_2$, is resistant to further anaerobic breakdown. Aerobic degradation, on the other hand, may cleave the aromatic rings[154] and it is possible that a combination is effective in nature. The method is inappropriate as a disposal technique because of the low concentrations of DDT and carefully controlled conditions that appear to be required and the slow degradation rates.

Other Methods

Degradation of DDT by ultraviolet light has been reported. The reaction is solvent-dependent and is promoted by benzene.[155] In ethanol the partially dechlorinated, coupled product $(ClC_6H_4)_2CH\text{-}CCl{=}CCl\text{-}CH(C_6H_4Cl)_2$ is produced and in γ-valerolactone the photo-oxidized product $(ClC_6H_4)_2C{=}O$ is obtained.[147] Aromatic amines also sensitize the photodecomposition of DDT.[133] Both DDT and DDE can be photo-oxidized in methanol[156] to give chlorinated phenols, aromatic ketones, benzoic acid and other products, including dichlorofluorene in the case of DDE. In the present state of development photolysis does not appear suitable as a disposal method for DDT.

Degradation has also been effected by Lewis acids such as $AlCl_3$, $AlBr_3$ and $FeCl_3$ and by certain free radical reactants such as benzoyl peroxide.[48,147] In both instances DDE is a substantial product and therefore these are not acceptable disposal methods.

DDT Relatives

Several dozen analogues of DDT have been synthesized and investigated as pesticides. Only a few of these have become of commercial importance in the United States, as indicated by the following list:

Acaralate®
Chlorobenzilate
DDD
Dicofol
Dilan®
Dimite®
Methoxychlor
Perthane®

Some of these such as DDD and some of those which have not been accepted, such as the fluoro analogue $(FC_6H_4)_2CH\text{-}CCl_3$ (DFDT), are chemically and environmentally as stable as DDT and present similar disposal problems. Others such as methoxychlor are much less persistent and quite probably newer analogues of a "soft" nature will be produced in time.[157] Comments on the chemistry of specific compounds follow:

Methoxychlor: $(CH_3O\text{-}C_6H_4\text{-})_2CH\text{-}CCl_3$ is like DDT in that it is resistant to heat and oxidation.[86] By some accounts[8,86] it is less readily dehydrochlorinated by alkali than is DDT, but other data[90] indicate little difference. The dehydrochlorination is catalyzed by heavy metals.[8,86] Methoxychlor is dechlorinated by refluxing with sodium in isopropyl alcohol.[92] It is described as resistant to ultraviolet light,[92] but other studies have shown that it breaks down rapidly under UV in hexane solution.[158] Incineration is recommended by the MCA manual[14] as the disposal method for methoxychlor.

DDD (also called TDE): The chemical properties of $(ClC_6H_4\text{-})_2CH\text{-}CHCl_2$ are similar to DDT, but it is apparently dehydrochlorinated slightly more slowly by alkali.[8,90] It is reduced by sodium in isopropyl alcohol.[92]

Perthane®: $(C_2H_5\text{-}C_6H_4)_2CH\text{-}CHCl_2$ is readily dehydrochlorinated like DDT.[90,92] It undergoes some thermal decomposition above 125°F and the ethyl groups are readily oxidized to carboxylic acid groups, but nitration is difficult.[92]

Dilan®: Dilan is a mixture of 21.3% Prolan ($R=CH_3$) and 42.7% Bulan ($R=C_2H_5$), both of which are degraded when heated:

$$(ClC_6H_4)_2CH\text{-}CH(NO_2)R \longrightarrow (ClC_6H_4)_2CH\text{-}CO\text{-}R + N_2O + H_2O$$

The reaction is aided by light and acid[83] and also by alkali.[86] Oxidizing agents produce a mixture of the corresponding ketones and acids[83] which are described as nontoxic.[86]

Dicofol (also called Kelthane): This compound is unstable in aqueous alkali and is degraded to dichlorobenzophenone and chloroform:[83,92]

$$(ClC_6H_4-)_2C(OH)-CCl_3 \xrightarrow{alkali} (ClC_6H_4)_2C{=}O + CHCl_3$$

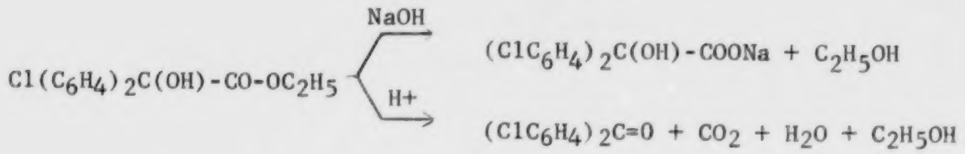
It is unaffected by concentrated H_2SO_4.[92]

Dimite®: Dimite® can be dehydrated with difficulty to the ethylenic product 4,4-dichlorodiphenyl ethylene:

$$(ClC_6H_4)_2C(OH)-CH_3 \longrightarrow (ClC_6H_4)_2CH{=}CH_2 + H_2O$$

Only 61% was reacted in 24 hr at 195°C,[83] but in the presence of 0.1 N H_2SO_4 in alcohol, 80% was dehydrated in 5 hr at reflux.[86]

Chlorobenzilate: Chlorobenzilate is easily hydrolyzed in strong alkali or acid.[92] The dichlorobenzilic acid is unstable and readily decarboxylates.[83]



$$Cl(C_6H_4)_2C(OH)-CO-OC_2H_5 \begin{cases} \xrightarrow{NaOH} (ClC_6H_4)_2C(OH)-COONa + C_2H_5OH \\ \xrightarrow{H+} (ClC_6H_4)_2C{=}O + CO_2 + H_2O + C_2H_5OH \end{cases}$$

Chlorobenzilate is dehalogenated by sodium in isopropyl alcohol.[92]

Chlorophenoxy Compounds

The phenoxy family of herbicides, of which 2,4-D is the most widely-used member, have the general structure $Cl_xAryl-O-(CH_2)_nCO-OM$ where M represents either the acid, sodium or amine salt, or ester form. The major entries are:

3-CP
4-CPA
2,4-D
2,4-DB
Dichlorprop
Erbon
MCPA
MCPB
MCPP
Sesone
Silvex
2,4,5-T

The acid and salt forms are readily interconvertible and generally undergo the same reactions. The ester forms do not give many of the reactions of the acid or salt forms. The esters can be hydrolyzed in alkali to the salt form.

2,4-D: This compound, $2,4\text{-}Cl_2C_6H_3\text{-}O\text{-}CH_2\text{-}COOH$, is considered to be nonpersistent, although it may last more than 1 yr in dry areas. Studies at 100 lb/acre have shown it is degraded by spreading on the land.[47] Since the ester forms are somewhat volatile, they should probably be hydrolyzed first (see above) to avoid drift, if this method of disposal is used.

Incineration of phenoxys is effective in 1 sec at 1800°F "using a straight combustion process" or at 900°F using "catalytic combustion".[15] Over 99% decomposition was reported when small amounts of 2,4-D were burned in a polyethylene bag.[49]

Other methods: Chlorination at pH 3 and 85°F for 10 min (using an excess of either gaseous chlorine or a sodium hypochlorite solution) renders the phenoxys nonherbicidal,[15] but the products were unstated and are possibly objectionable. Reduction of 2,4-D by sodium or lithium in liquid ammonia has been reported[62] as has oxidation with boric oxide in a Parr bomb, but neither method is suitable as a general disposal technique. Addition of soluble calcium (or magnesium) salts to solutions of 2,4-D acid or salts (but not the ester forms) produces the insoluble (solid) calcium 2,4-D salt.[15] This reaction can aid in collecting the 2,4-D but the product is still herbicidally active.

Degradation of 2,4-D is achieved in biological treatment facilities.[15]

2,4,5-T: The reactions of $2,4,5\text{-}Cl_3C_6H_2\text{-}O\text{-}CH_2COOH$ are essentially the same as those of 2,4-D. The MCA Manual[14] notes two disposal procedures for 2,4,5-T: (1) Mix the "excess" sodium carbonate, add water and let stand for 24 hr before flushing down the drain with excess water; and (2) pour onto vermiculite and incinerate with wood, paper, and waste alcohol.

Other Phenoxys

MCPP: $2\text{-}CH_3\text{-}4\text{-}Cl\text{-}C_6H_3\text{-}OCH(CH_3)\text{-}COOH$ is said to be "stable" to heat and "resistant" to hydrolysis, reduction and atmospheric oxidation.[8]

Erbon: $2,3,4\text{-}Cl_3C_6H_2\text{-}OC_2H_4O\text{-}CO\text{-}CCl_2CH_3$ is said to be nonflammable and stable to ultraviolet light.[8]

Sesone: $2,4\text{-}Cl_2C_6H_3\text{-}OC_2H_4\text{-}OSO_3Na$, is hydrolyzed by alkali[8] to $NaHSO_4$ and apparently the dichlorophenoxyethanol.

Aldrin-Toxaphene Group

The aldrin-toxaphene group of insecticides are all highly chlorinated cyclic or bicyclic compounds, but are prepared by two general routes which confer some distinct properties to the product. Members of the aldrin family, of which chlordane and aldrin are the most widely used, are all derived from hexachlorocyclopentadiene and are frequently referred to as the diene or cyclodiene group of insecticides.[159] Members of the toxaphene family (toxaphene is currently the most widely used insecticide in the U.S.) are all derived by direct chlorination of bicyclic hydrocarbons and all are mixtures of many compounds. Entries in each family are listed below:

Diene Family

Aldrin
Alodan
Bromodan
Chlordane
Dieldrin
Endosulfan
Endrin
Heptachlor
Isodrin
Kepone®
Mirex
Pentac®
Telodrin

Toxaphene Family

Bandane®
Strobane
Toxaphene

In general, the diene family appears to be the more environmentally persistent, but this conclusion may be based on inadequacies in the analytical methods for the complex mixtures in toxaphene and related chlorination products. For purposes of discussing the disposal chemistry of this group of insecticides it is helpful to divide the aldrin-toxaphene groups into subgroups according to reaction chemistry rather than production chemistry.

The Aldrin, Dieldrin, Endrin Subgroup

Aldrin: Aldrin is very stable thermally with no decomposition noted at 250°C.[92] Aldrin (along with the structurally related compounds dieldrin and isodrin) is remarkably stable to alkali (in contrast to chlordane and heptachlor[159] and refluxing with aqueous or alcoholic caustic has no effect.[92] Aldrin (along with dieldrin and endrin) is said by one source[15] to be "dehydrochlorinated" in an acid solution of less than pH 3.0, but another source[160] says it is stable with "dilute" acids but reacts with concentrated mineral acids, acid catalyst, acid oxidizing agents and active metals. The reaction with acid may be a structural rearrangement to a less insecticidally active form, based on knowledge of endrin.

The unchlorinated double bond of aldrin readily adds chlorine (or bromine), but the product would probably be more persistent than aldrin. This bond also reacts with halogen acids, organic acids and alcohols in the presence of acidic catalyst to form addition products such as halides, esters and ethers.[86]

Aldrin is removed from aqueous solution by aeration.[161] Volatilization was probably the primary process but some oxidation (at the unchlorinated double bond) to dieldrin may have occurred: this reaction is known to occur in the environment and oxidation with peroxyacetic acid is the process used commercially to produce dieldrin from aldrin. Surprisingly enough, hydrogen peroxide and sodium peroxide are said[161] to have no measurable effect on aldrin. Ozonation of aldrin solutions was much more effective than aeration.[161] No attempt was made to identify the products, but reaction probably occurs at both double bonds to give the tetracarboxylic acid which may in turn react slowly to give other products such as CO_2. Aldrin in aqueous solution was also readily attacked by chlorine,[161] but another account notes that chlorine adds to the unchlorinated double bond[86] to give a more highly chlorinated (and probably more persistent) product. Oxidation with potassium permanganate, on the other hand, opens the unchlorinated ring to give the dicarboxylic acid,[86] but the environmental hazard of this compound is uncertain. Thus, none of these oxidation methods can be recommended as a disposal method.

Incineration methods for aldrin disposal have been recommended by the MCA Manual[14] and the combustion of aldrin in polyethylene on a small scale gave more than 99% decomposition.[49]

Aldrin can be degraded by active metals such as sodium in alcohol (a reaction which forms the basis of the analytical method for total chlorine), but this method is not suitable for the layman.

A disposal method suggested[162] for materials contaminated with aldrin, dieldrin or endrin consists of burying 8 to 12 ft underground in an isolated area away from water supplies, with a layer of clay, a layer of lye and a second layer of clay beneath the wastes.

Dieldrin: Dieldrin like aldrin (from which it is derived by oxidation) is quite stable to heat (no decomposition at 250°C) and to refluxing aqueous or alcoholic caustic.[92] The instability of dieldrin to acids is similar to that of aldrin. Dieldrin is more resistant to oxidation than is aldrin, but is attacked by ozone:[161] Reaction would be expected to occur at the double bond and at the epoxide to give the tetracarboxylic acid (see aldrin). Dieldrin is 100% degraded by sodium or lithium in liquid ammonia[62] but this is not a practical disposal method. The MCA Manual recommends incineration methods for the disposal of dieldrin.[14]

Endrin: Endrin is a stereoisomer of dieldrin and has similar chemistry: It is stable to alkalis.[92] It is apparently stable with dilute acids,[160] but rearranges with strong acids, acid catalysts or certain metals or when heated above 200°C to give a compound which is insecticidally less active than is endrin.[8,92,160]

A disposal procedure recommended by the manufacturer[163] consists of absorption, if necessary, and burial at least 18 in. deep, preferably in sandy soil in a flat or depressed location away from wells, livestock, children, wildlife, etc.

Isodrin: Isodrin is the stereoisomer of aldrin and would be expected to pose analogous disposal problems--see aldrin.

Chlordane-Heptachlor-Toxaphene Subgroup

Chlordane and related compounds: Chlordane is readily dehydrochlorinated[86] in alkali to form "nontoxic" products, a reaction catalyzed by traces of iron. The environmental hazards of the products are uncertain. Chlordane is completely dechlorinated by sodium in isopropyl alcohol.[92] The MCA Manual recommends incineration methods for disposal of chlordane.[14]

Heptachlor: Heptachlor is said to be stable to at least 160°C and to light, moisture, air and oxidizing agents, acids and apparently alkali,[86,92] although one account[159] indicates that its susceptibility to alkali is like that of chlordane rather than the aldrin subgroup. Heptachlor is rather easily converted to the epoxide in soil and plants[92] and one would suppose this reaction would occur with peroxides. Heptachlor is decomposed in the presence of iron at 160°C and above.[163] The MCA Manual recommends incineration methods for disposal of heptachlor.[14]

Toxaphene: Toxaphene has the approximate composition $C_{10}Cl_8H_{10}$. It consists of mixture of 20 to 30 compounds resulting from the chlorination of camphene, but is predominantly a mixture of the octachlorocamphene isomers. "Toxaphene" is said to dehydrochlorinate in the presence of alkali, upon prolonged exposure to sunlight, and at temperatures of about 155°C.[86] Reduction with sodium in isopropyl alcohol is the analytical method for total chloride.

Strobane: Strobane consists of a mixture of compounds obtained by chlorinating a mixture of camphene and α-pinene (which is an isomer of camphene) and has approximately the composition $C_{10}Cl_8H_{10}$ also. Like toxaphene, strobane is unstable in the presence of alkalis and organic bases and is slowly dehydrochlorinated at 100°C.[8] Strobane-T is said to resemble more closely the mixture of compounds present in toxaphene and is the product now marketed.

Other Members

Endosulfan (also called Thiodan): Endosulfan is a sulfur-containing compound and unlike most of the hexachlorocyclopentadiene family, is sensitive to moisture, bases and acids. It is slowly hydrolyzed to give SO_2 and the corresponding diol $C_7Cl_6(CH_2OH)_2$.[8,92,114] The analytical method is based on reaction with NaOH in methanol: Heat 0.7 g endosulfan with 100 ml methanol and 3 to 4 g NaOH for 2 hr on a hot plate or under reflux.[92] (The SO_2 is largely retained as sodium sulfite.) Endosulfan is said to give calcium sulfate with lime.[114] Endosulfan is stable in sunlight. A recommended method for disposal is burial 18 in. deep in noncropland away from water supplies,but bags can be burned.[114]

Mirex, $C_{10}Cl_9O$: This highly chlorinated compound is unaffected by mineral acids (HCl, HNO_3 and H_2SO_4).[8] It would be expected to be extremely resistant to oxidation except at the high temperature of an efficient incinerator.

Pentac, C_5Cl_5-C_5Cl_5: This perchlorinated compound is stable to aqueous acids and bases. It loses activity upon heating (50% loss after 6 hr at 130°C) or upon exposure to sunlight or ultraviolet light.[8]

Aliphatic and Alicyclic Chlorinated Hydrocarbons

The chlorinated aliphatics can be conveniently divided into three subgroups: (a) the volatile liquid fumigants such as carbon tetrachloride; (b) the low-volatility cyclohexane derivatives, lindane and BHC; and (c) the partially oxidized derivatives such as trichloroacetic acid which are also of low volatility.

Alorac
BHC
Carbon tetrachloride
Chloroform
Dalapon
D-D
Dichloromethane
EGT
Ethylene dichloride
HCA
Lindane
Sodium cis-3-chloroacrylate
TCA
Tetrachloroethylene
1,1,1-Trichloroethane

These compounds show a wide range of toxicities, physical properties and environmental persistence. In general, these compounds are nonflammable and can be burned only at elevated temperatures. The compounds are grouped into the categories indicated above for purposes of discussion of disposal aspects.

The Chlorinated Fumigants

Carbon tetrachloride: This compound has a relatively high oral LD$_{50}$ (7,460) compared to most insecticides, but is a toxic inhalant: (TLV = 10 ppm,[80] see p. 38) and is also absorbed through the skin. The MCA Manual[14] recommends evaporation in a fume hood as a disposal method. The rate of degradation in the atmosphere is uncertain. Carbon tetrachloride has been used as a fire extinguishing agent, but it can give dangerous amounts of the much more toxic compound phosgene ($COCl_2$) and users should not remain in unventilated areas. Complete combustion of CCl_4 at flame temperatures produces CO_2 and corrosive hydrogen chloride.

Chloroform, dichloromethane, and 1,1,1-trichloroethane: The MCA Manual[14] recommends landfill disposal or release to the air for these compounds, all of which are less toxic than CCl_4: TLV's are 50 ppm, 500 ppm, 350 ppm, respectively.[80]

D-D®: This material is a mixture of four dichloropropanes and dichloropropenes plus related chlorinated C_3 hydrocarbons. The LD$_{50}$ of the mixture is 140 mg/kg. The MCA Manual recommends incineration methods of disposal.[14] One source[106] notes that D-D® reacts with dilute inorganic bases, concentrated acids, some metal salts, and active metals, as well as undergoing further halogenation. D-D® was said to be unstable in soil.[106]

Ethylene dichloride (or 1,2-dichloroethane), and tetrachloroethylene: The MCA Manual[14] recommends incineration methods for disposal of these compounds (TLV's are 500 ppm and 100 ppm, respectively).[80]

Chlorinated Aliphatic Derivatives

Alorac: Alorac, a chlorinated pentanoic acid derivative, $CCl_3\text{-}CO\text{-}CCl{=}CCl\text{-}COOH$, is used as a cotton defoliant and is phytotoxic to other plants. It is a solid of low solubility (6 g/liter) in water, but soluble in organic solvents.[2]

Dalapon, sodium salt: This product (LD$_{50}$ = ~ 8,000 mg/kg) is dehydrochlorinated by alkali above 120°C.[8]

$$CH_3CCl_2COONa \xrightarrow[120^\circ C]{Base} CH_2{=}CClCOONa$$

It undergoes hydrolysis of both chlorine atoms in aqueous solution at or above 50°C (and slowly even at 25°C) to give herbicidally inactive pyruvic acid:

$$CH_3CCl_2COONa \xrightarrow{H_2O} CH_3COCOONa$$

Dalapon reacts with sodium or lithium in liquid ammonia.62/ Dalapon underwent charring when heated alone, underwent exothermic decomposition when heated with the oxidants KNO_3 and $KClO_3$ (above 187°C and 140°C, respectively), and was > 99% decomposed when burned in a polyethylene bag, but toxic phosgene gas was detected in the products.49/

HCA (hexachloroacetone): HCA is hydrolyzed slowly in water or rapidly in alkalis to give trichloroacetic acid (see TCA below).

Sodium cis-3-chloroacrylate (also called Prep): This compound, $CHCl{=}CH\text{-}COONa$, is used as a defoliant and desiccant and is said to be normally nonpersistent.5/ It is moderately toxic. It is more soluble in water than some of the other compounds in this category, but insoluble in most organic solvents.5/

TCA (trichloroacetic acid and sodium trichloracetate): TCA is a corrosive strong acid and the product is usually used as the less toxic sodium salt (LD_{50} = 5,000 mg/kg). The TCA or sodium salt tends to decarboxylate to give chloroform under strongly alkaline conditions, e.g., treatment with 30% NaOH,8/ and is known to undergo slow decomposition in dilute solutions.164/

Cyclohexane Derivatives

BHC and lindane ($C_6H_6Cl_6$): BHC (the so-called benzene hexachloride) is a mixture of five isomeric compounds of 1,2,3,4,5,6-hexachlorocyclohexane plus small amounts of the hepta- and octa-chloro derivatives. Lindane is the strongly insecticidal γ-isomer. The composition of BHC is variable between manufacturers and has changed over the years, with an increase in the content of the γ-isomer.

The BHC isomers are stable to light, air, and strong acids, but undergo dehydrochlorination upon prolonged heating (e.g., 110°C for 24 hr)165/ or in strongly alkaline solution at room temperature (excepting the β-isomer which constitutes about 6% of BHC)8/ e.g., lindane was 98.5% removed in 6.5 hr at pH 11.5.55/ Studies with BHC in alcoholic alkali (e.g., 1.5 N) indicate the reaction is complete in 1 hr90/ and that the product is a mixture of 1,2,4-trichlorobenzene (65 to 85%) with smaller amounts of the 1,2,3-isomer (5 to 18%) and the 1,3,5-isomer (0 to 15%).86/

Oxidation of lindane was ineffective with Cl_2 or H_2O_2, partially effective with $KMnO_4$, and effective with ozone[161] but the products were not identified.

Aeration of aqueous lindane solutions caused volatilization.[161] Reduction with zinc dust in acid medium converted BHC to benzene.[83]

The MCA Manual recommends incineration methods for the disposal of lindane.[14] A process has been patented[166] for the destructive pyrolysis of benzene hexachloride at 400° to 500°C with a catalyst mixture which contains 5 to 10% of either cupric chloride, ferric chloride, zinc chloride, or aluminum chloride on activated carbon.

Aliphatic Brominated Compounds

Five bromine-containing compounds are used as pesticides.

Bis-1,4-bromoacetoxy-2-butene
DBCP
EDB
Methyl bromide
Propargyl bromide

They are similar to the aliphatic chlorine compounds in uses and disposal procedures.

DBCP (1,2-dibromo-3-chloropropane): DBCP is reported to be stable to neutral and acid media. It is hydrolyzed by alkali to 2-bromoallyl alcohol. For recommended disposal procedure see EDB (below).

EDB (ethylene dibromide); The Manufacturing Chemists Association suggests[14] the following disposal procedures for EDB and other bromine-containing compounds.

* "Pour onto vermiculite, sodium bicarbonate or a sand-soda ash mixture (90-10). Mix and shovel into paper boxes. Place in an open incinerator. Cover with scrap wood and paper. Ignite with an excelsior train; stay on upwind side. Or dump into a closed incinerator with afterburner."

* "Dissolve in a flammable solvent. Spray into the fire box of an incinerator equipped with afterburner and scrubber (alkali)."

Methyl bromide: Methyl bromide is a very toxic gas (b.p. = -3.6°C) at room temperature, and the concentration should not be allowed to exceed 20 ppm in air used for breathing. It is ordinarily marketed as a condensed liquid (which may have a warning agent added) in a pressurized container. The MCA Manual recommended[14] disposal procedures are the same as for EDB above, but only the latter is at all practical, i.e., spray the gas into the fire box of an incinerator equipped with an afterburner and scrubber (alkali). However, incineration of such a toxic gas by the layman appears too hazardous to be recommended. Methyl bromide is apparently degraded rapidly in the sunlight in air and a preferable disposal procedure for the layman would be to release small amounts slowly to the atmosphere in a well-ventilated outdoor location. The cylinders can also be returned to the manufacturers.

Propargyl bromide: The MCA Manual recommended[14] disposal procedures are the same as for EDB (above).

Dihaloaromatic Compounds

Ten compounds which contain two chlorine or bromine atoms on the same ring of a relatively simple aromatic structure have been used as pesticides.

Bromoxynil
Bromoxynil, octanoate
Chloramben
Chloroneb
Dicamba
Dichlobenil
Dichlone
Disugran
Orthodichlorobenzene
Paradichlorobenzene

Of these, chloramben, dicamba and dichlobenil are herbicides, chloroneb is a fungicide, disugran is a growth regulator, and the dichloro benzenes are fumigating insecticides and fungicides. Dichlone, a fungicide, is a naphthalene derivative but is included here for convenience. All the compounds in this group are of low to moderate toxicity and do not appear to present serious environmental or disposal problems. Specific comments are:

Bromoxynil: This selective herbicide is a 4-hydroxy, dibromo analogue of dichlobenil (although the latter is somewhat less toxic), and is marketed as the water-soluble alkali salts or as the oil-soluble octanoate ester. It is less persistent than dichlobenil,[8] and disposal on the ground surface appears to be practical for small amounts. Incineration of bromoxynil would produce HBr and nitrogen oxides which should be removed in a caustic scrubber.

Ioxynil, the iodinated analogue of bromoxynil was included with the nitrogen-containing pesticides, as it appears to be nonpersistent.

Chloramben: Chloramben, also called amiben, is the major herbicide of this group. It is stable to heat, oxidation, and hydrolysis in acidic or basic media.8/ The stability is comparable to that of benzoic acid.2/ Chloramben is decomposed by sodium hypochlorite solution.8/

Chloroneb: Chloroneb is stable at its boiling point (268°C), in water in the presence of dilute acids or alkalis, and in the common organic solvents.137/

Dicamba: Dicamba is stable to oxidation and is resistant to acid and strong alkali.163/ It is degraded by sodium or lithium in liquid ammonia.62/

Dichlobenil: This herbicide, 2,6-dichlorobenzonitrile, is stable to heat and to acids, and is moderately persistent in soils.8/ It is hydrolyzed by alkali to the benzamide,8/ but this does not appear to be a sufficiently complete degradation for disposal purposes. Incineration would be preferable as a disposal method.

Highly Halogenated Aromatic Compounds

The compounds in this group contain three or more chlorine (or in one case iodine) atoms per aromatic nucleus:

p-Chlorophenyl-2,4,5-trichlorophenyl sulfide
[(p-Chlorophenyl)thio] (2,4,5-trichlorophenyl)diimide
Chlorothalonil
DCPA
O,S-Dimethyltetrachlorothioterephthalate
Fenac
HCB
Hexachlorophene
PBA
PCP
2,3,6-TBA
TBP
TCBC
2,3,4,6-Tetrachlorophenol
Tetradifon
TIBA
Tricamba
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Most of these compounds are either herbicides or fungicides, although some also have other pesticidal uses, e.g., the chlorophenols against termites and hexachlorophene as a disinfectant and in personal products. Hexachlorophene may be the most environmentally persistent compound in the group.

p-Chlorophenyl-2,4,5-trichlorophenyl sulfide (tetrasul): This miticide can be oxidized[8/] to its sulfone, tetradifon (see above) and poses similar disposal problems. It is apparently degraded in sunlight.[8/]

Chlorothalonil: Chlorothalonil is stable in aqueous acid and alkali and to ultraviolet light and is noncorrosive.[8/]

DCPA (Dacthal®): DCPA, the dimethyl ester of tetrachloroterephthalic acid, is a pre-emergent herbicide with a half-life in soil of about 100 days[8/] and is only moderately toxic. It is very insoluble in water, but soluble in organic solvents. Incineration of these solutions could be used for disposal with proper precautions for the HCl formed, i.e., caustic scrubbers would be required for any large amounts.

O,S-Dimethyltetrachlorothioterephthalate: This compound a thio analogue of Dacthal®, above is hydrolyzable (to tetrachloroterephthalic acid, methanol and methyl mercaptan) by concentrated acid or alkyl. It will undergo slight degradation when exposed to intense ultraviolet radiation.[5/] The presence of stable, chlorinated-aromatic groups in this compound preclude disposition by chemical detoxification. Incineration (with precautions to prevent air pollution) would be the disposal method of choice.

HCB (Hexachlorobenzene): The MCA Manual[14/] recommends incineration methods of disposal.

PCP (pentachlorophenol and sodium pentachlorophenate): Pentachlorophenol is a strong acid, although generally noncorrosive in the absence of moisture. It is nearly insoluble in water, but soluble in most organic solvents, while the sodium salt is soluble in water, but is insoluble in oils.[8/] Photolysis of aqueous PCP by sunlight produces a series of degradation products in which chlorine atoms are replaced by hydroxyl groups followed by air-oxidation to quinones and other reactions:[87/] Principal products are $C_6Cl_4(OH)_2$, $C_6Cl_2O_2(OH)_2$, the coupled compounds $C_6Cl_5\text{-}O\text{-}C_6Cl_2O_2(OH)$, $C_6Cl_4(OH)\text{-}C\text{-}C_6Cl_2O_2(OH)$, and $C_6Cl_4(OH)\text{-}O\text{-}C_6Cl_3O_2$. Under ultraviolet irradiation in methanol solution, PCP underwent reductive dechlorination to give tetrachlorophenol (the 2,3,5,6 isomer only), but irradiation of an aqueous suspension of PCP gave humic acid (an unchlorinated polymeric material).

PCP is nonflammable alone, but the MCA Manual[14/] recommends incineration methods of disposal.

2 3,6-TBA: 2,3,6-Trichlorobenzoic acid is usually used in the form of its dimethyl amine salt which is said to be chemically stable, but to undergo some decomposition when its aqueous solutions are evaporated to dryness and

to lose amine at high pH.[137] The acid is slightly soluble in water, and is stable in air up to at least 60°C, and to light.[8]

TCBC: Trichlorobenzylchloride (mixed isomers) is slightly volatile liquid which is nearly insoluble in water (2 ppm). It begins to decompose at 90°C in the presence of anhydrous ferric chloride and is corrosive to steel, but is stable to ultraviolet light.[8]

Tetradifon: The sulfur atom in this miticide, p-chlorophenyl-2,4,5-trichlorophenyl sulfone, is quite inactive and the compound is very nontoxic, LD_{50} = 14,700 mg/kg. Tetradifon is quite stable in dilute alkali and strong acid solutions[92] and, is even resistant to the action of mineral acids and alkalis upon prolonged heating.[83] It is not oxidized by chromium trioxide in boiling acetic acid, but is dechlorinated by sodium in isopropyl alcohol or (rapidly) by sodium biphenyl solution.[8]

TIBA: TIBA, a plant growth regulator, is a triiodobenzoic acid. It is probably not persistent in the environment as the intact molecule, but iodide ion would persist. The Manufacturing Chemists Association[14] suggests that iodine-containing compounds be incinerated using the same procedures as those recommended for chlorinated compounds, i.e., an afterburner and caustic scrubber should be used for large amounts, because of the formation of HI or I_2.

Other Chlorinated Compounds

A few additional compounds which contain only one or two chlorine atoms are used as pesticides. The products of interest are:

Chloranil
Dichloroethyl ether
Parinol
TCTP

Comments on the degradation of specific compounds are:

Chloranil: Chloranil, a chlorinated quinone, is partially dechlorinated in alkaline solutions to form alkali salts of chloranilic acid, $C_6Cl_2O_2(OH)_2$ and is quantitatively reduced by potassium iodide to give tetrachlorohydroquinone $C_6Cl_4(OH)_2$.

2,2'-Dichloroethyl ether: This soil fumigant has a high acute mammalian toxicity and air containing more than 15 ppm should not be breathed. (It does not, however, appear to have the carcinogenic properties present in α-chloro ethers.) It is also phytotoxic and should be disposed with care. The MCA Manual[14] recommends two disposal procedures: pouring on the ground and then either allowing to evaporate or igniting from a safe distance, and; dissolving in a flammable solvent followed by incineration.

Parinol: Parinol $(ClC_6H_4)_2C(OH)C_5H_4N$, is stable in acid and alkali.[2] The structure is somewhat similar to that of DDT.

TCTP (Tetrachlorothiophene): TCTP is stable to acids and alkalis, but is slowly hydrolyzed with rupture of the ring when refluxed with sodium methylate.[8] It is nonflammable and noncorrosive.

SULFUR-CONTAINING PESTICIDES

In addition to the many sulfur-containing organic compounds previously covered in the sections on phosphorus-, nitrogen- or chlorine-containing pesticides, a number of other pesticides have sulfur-containing functional groups as the primary active unit. Most of these compounds do not pose serious toxicity or environmental hazards. Disposal by incineration methods would be generally effective, except that SO_2 would be a product and is objectionable: incineration of sizeable amounts should be done in equipment containing caustic scrubbers. Many of the compounds are also susceptible to chemical degradation.

Sulfides, Sulfoxides and Sulfones

Six compounds are grouped under this category:

Chlorbenside
Dimethyl thiocarbonyl disulfide
MGK Repellent 874®
Polyethylene polysulfide
Sulfoxide
Sulphenone

Chlorbenside: Chlorbenside is oxidized by air or other oxidizing agents to the corresponding sulfoxide and sulfone, both of which have approximately the same acaricidal effects as the sulfide. The relatively low toxicity of chlorbenside (rats tolerated a diet of 10,000 mg/kg/day for 3 weeks) and its low persistence in soil[8/] suggests that burial or careful burning would be acceptable (with care to prevent exposure to combustion products, HCl and SO_2).

MGK Repellent 874®: This relatively nontoxic sulfide (LD_{50}-8500) could be disposed of by efficient incineration, if acceptable, by open burning.

Sulfoxide: Sulfoxide is resistant to alkaline hydrolysis. Oxidation to the sulfone produces an oxidation-resistant compound of similar moderate toxicity. Incineration or open burning with proper precautions is suggested.

Sulphenone: The monochloro-diphenyl sulfone is very resistant to hydrolysis or oxidation. Incineration under proper conditions to prevent air pollution would be effective (scrubbers to absorb HCl and SO_2).

Sulfites and Xanthates

Four compounds are grouped in this category:

Aramite
EXD
Propargite
Sodium isopropyl xanthate

Aramite (sulfite): Aramite is readily hydrolyzed by alkalis or mineral acids (acids result in the liberation of sulfur dioxide). In sunlight it breaks down relatively rapidly with the evolution of sulfur dioxide.[83]

EXD: EXD is rapidly decomposed by alkalis producing harmless ethanol and liberating carbon disulfide. (Carbon disulfide would present a hazard if large quantities of this product were to be disposed of by this procedure, see p. 123).

Propargite: Incineration of this compound would produce sulfur dioxide which, in small quantities, would not constitute a serious air pollution hazard.

Sodium Isopropyl Xanthate: This compound which has "low mammalian toxicity"[11]. is rapidly decomposed by mineral acids to relatively harmless isopropyl alcohol and carbon disulfide (see EXD above).

Sulfonic Acids and Derivatives

Five compounds are grouped in this category:

Antiresistant/DDT
4,4'-dichloro-N-methylbenzenesulfonanilide
Fenson
Genite (923)®
Ovex

Antiresistant/DDT: This sulfonamide, which is used as a synergist for DDT is not likely to be a candidate for disposal alone. It is of low toxicity and could be effectively incinerated if precautions are taken to insure that the resultant production of sulfur, nitrogen oxides and HCl causes no difficulty.

4-4'-dichloro-N-methylbenzenesulfonanilide: This compound is structurally similar to Antiresistant/DDT and disposal aspects would be similar.

Fenson, Genite (923)® and Ovex: These three miticides are structural analogues. Alkaline hydrolysis produces compounds of greater toxicity, p-chlorophenol (LD_{50} = 670) or dichlorophenol. The compounds are relatively resistant to oxidation. Incineration of these products would be acceptable if precautions were taken to eliminate air pollution (employ caustic scrubbers to trap HCl and SO_2).

Thiocyanates

Four compounds have the thiocyanate, -SCN, structure.

Benzyl Thiocyanate
Lethan 384®
Thanite
2-Thiocyanatoethyl laurate

The toxic thiocyanate group is well known to be hydrolyzed and oxidized by alkaline hypochlorite. Alkaline hydrolysis produces the corresponding disulfide, sodium cyanide and sodium cyanate. Prolonged treatment with alkali results in complete detoxification of cyanide and cyanate (see Inorganic Pesticides). Hypochlorite will oxidize the disulfide to the relatively nontoxic sulfonic acids which would be relatively nontoxic and nonpersistent in the environment. Under acidic or reducing conditions, the thiocyanates may form HCN and such conditions should be avoided.

Thanite: This yellow liquid household insecticide is highly toxic to plants, but animals exposed to heavy mist (5%) of Thanite in kerosene for 8 hr daily for 6 months showed only minor ill effects.[67/] Chemically, it should be susceptible to alkaline hypochlorite degradation.

Other Sulfur-Containing Compounds

Four other sulfur-containing pesticides are:

Carbon disulfide
Disodium Cyanodithioimidocarbonate
2-Hydroxypropylmethanethio sulfonate
Sulfuryl fluoride

Carbon disulfide: This compound is a very flammable liquid which evaporates rapidly. It burns with a blue flame to carbon dioxide (harmless) and sulfur dioxide. Sulfur dioxide has a strong suffocating odor; 1,000 ppm in air is lethal to rats. The pure liquid presents an acute fire and explosion hazard. The Manufacturing Chemists Association suggests[14] the following disposal procedure.

> "All equipment or contact surfaces should be grounded to avoid ignition by static charges. Absorb on vermiculite, sand, or ashes and cover with water. Transfer underwater in buckets to and open area. Ignite from a distance with an excelsior train. If quantity is large, carbon disulfide may be recovered by distillation and repackaged for use."

Sulfuryl fluoride: The following disposal method has been suggested for this gaseous inorganic fumigant:[14] allow gas to flow into a mixed solution of caustic soda and slaked lime. After neutralization, the solution,which is relatively harmless, may be washed down the drain. The precipitated calcium fluoride may be buried or added to a land fill (see sodium fluoride). Small amounts could also be released directly to the atmosphere without serious harm.

BOTANICAL AND MICROBIOLOGICAL PESTICIDES

The pesticides included in this classification are those obtained from natural products or cultures, plus certain synthetic compounds which are closely related structurally to the naturally occurring product.

Allethrin
Bacillus thuringiensis
Barthrin
Dimethrin®
D-Trans allethrin
Gibberellic acid
Piperonyl butoxide
Piperonyl cyclonene
Propyl isome
Pyrethrins
Red Squill
Rotenone
Ryania
Sabadilla
SBP-1382
Streptomycin
Strychnine
Tetramethrin
Tropital®

Not included in this list is nicotine which was discussed with nitrogen-containing pesticides. These compounds are used variously as insecticides, rodenticides, repellents, synergists and plant growth regulators. The mammalian toxicity of these compounds varies from the extremely toxic strychnine (LD_{50} = 5 mg/kg) to virtually nontoxic. Some such as rotenone are very toxic to fish so that they should not be disposed of carelessly.

Compared to most other pesticides, the botanical and microbiological pesticides are very complex organic molecules and are very susceptible to degradation and detoxification by heat and chemical reagents. Incineration would be a generally effective disposal procedure for the pesticides. Treatment with alkaline hypochlorite would also generally result in effective degradation.

The following is a brief summary of the disposal-related chemistry pertaining to botanicals.

Allethrin: Allethrin is detoxified by hydrogenation of the double bonds in the molecule. It is more stable than natural pyrethrin (see below) to UV radiation and heat.[86]

Bacillus thuringiensis: This microbial product is produced by fermentaion culture methods. It is considered harmless to mammals and hymenopterous pollenators and is specific for the larvae stage of lepidopterous insects.[1] It degrades readily in the environment and poses little or no disposal problem.

Barthrin: A pyrethrum analog. (See pyrethrum for disposal recommendations.)

Dimethrin®: This relatively nontoxic pyrethrum analog is decomposed by alkali. (See pyrethrum for other disposal recommendations.)

Gibberellic Acid: The gibberellins are probably nontoxic to humans.[138] Burial or incineration (where permitted) would be effective disposal procedures.

Piperonyl Cyclonene: These compounds are detoxified by strong acid[92] or strong base. Incineration is effective (where permitted); air pollution hazard is minimal since CO_2 and H_2O are only products of complete combustion. Burial with lime would not cause environmental harm.

Propylisome: For disposal procedures, see piperonyl cyclonene (above).

Pyrethrin: This product, a mixture of several structurally related compounds, is produced by extraction of certain plants. It is highly unstable in the presence of light, moisture, and air.[86] It is rapidly oxidized and inactivated by air. Most of the insecticidal activity of the product is destroyed by minor changes in the molecule.

Pyrethrin products are not apt to be disposal candidates. It could be dumped into a landfill,[14] or buried in noncrop land away from water.[114] In each of these cases it would be better to mix the product with lime. Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided.

Streptomycin: This white, solid, water-soluble antibiotic, which is produced by culture methods, is used as a fungicide and bactericide. Contact with skin or eyes should be avoided. Do not breathe dust or spray mist. Streptomycin is unstable to heat and does not accumulate in the soil.[93] Therefore, disposal by incineration or burial should not result in harm to the environment.

Red Squill: Red Squill loses its toxicity to rats if dried at 80°C. When exposed to air and moisture, it loses toxicity in a few months.[93] Burial with alkali or lime is an effective disposal procedure, as is incineration.

Rotenone: Rotenone is decomposed by light and alkali to less insecticidal products.[8] It is readily detoxified by the action of light and air. It is also detoxified by heating; 2 hr at 100°C results in 76% decomposition. Oxidation products are probably nontoxic.[86] Incineration has been recommended as a disposal procedure.[14] Burial with lime would also present minimal danger to the environment.

Ryania: Ryania is considerably more stable to heat and atmospheric oxidation than pyrethrin.[86] It is stable to light and does not decompose on storage.[93] Incineration (see pyrethrum) or burial with lime are effective disposal methods.

Sabadilla: The alkaloids present in this product are rapidly destroyed by the action of light. Careful incineration is an effective disposal procedure. Burial with lime is not recommended because the product is relatively stable toward alkali and is frequently formulated with lime.

SBP-1382: This product, a pyrethrum analog, decomposes fairly rapidly on exposure to air and light. See pyrethrum for disposal recommendations.

Strychnine: Strychnine is the most toxic product (LD_{50} = 5 mg/kg) in the botanical group. Careful incineration has been recommended; two procedures[14] are suggested.

* "Pour or sift onto a thick layer of sand and soda ash mixture (90-10). Mix and shovel into a heavy paper box with much paper packing. Burn in incinerator. Fire may be augmented by adding excelsior and scrap wood. Stay on the upwind side."

* "Waste may be dissolved in flammable solvent (alcohols, benzene, etc.) and sprayed into fire box of an incinerator with afterburner and scrubber."

Tropital®: Tropital® is unstable when exposed to sunlight for over 1 week. It is heat sensitive above 150°C.[8] It is decomposed by mineral and strong organic acids. Careful incineration or burial with acid is suggested.

ORGANIC PESTICIDES, Not Elsewhere Classified

A large number of other synthetic organic compounds, most but not all of which contain carbon, hydrogen and oxygen, are used as pesticides. For convenience, these compounds are grouped into those with less than 9 carbon atoms, those with more than 9 carbon atoms, and a special small group of compounds with anticoagulant properties.

Organic Compounds, < 9 Carbon Atoms

Compounds in this group have a wide range of uses, properties and toxicities. Included are some extremely toxic compounds such as sodium fluoroacetate and acrolein which require unusual care.

Acetic acid
Acrolein
Allyl alcohol
Benzene
Dehydroacetic acid
Endothal
Ethylene
Ethylene oxide
Ethyl formate
Ethyl hexanediol
Formaldehyde
Metaldehyde
n-Octanol
2-Propene-1,1-diol diacetate
Propionic acid
Propylene oxide
Sodium fluoroacetate
Sorbic acid

In general, the best disposal method for most compounds in this group is incineration. Incineration is specifically recommended[14/] for ten compounds in this group and would be acceptable for most of the others. Complete combustion of these products would produce only CO_2 and water, except in the case of sodium fluoroacetate.

Liquids should be atomized into an incinerator[14/] and combustion may be improved by mixing with a more flammable solvent (acetone or benzene). Solids should be combined with paper or other flammable material. An alternate procedure is to dissolve the solid in a flammable solvent and spray the solutions into the fire chamber. Some special precautions and some other decontamination procedures are discussed below.

Acrolein: The high toxicity of this water-soluble liquid can be greatly decreased by treatment with water and an excess of 10% sodium bisulfite.[162] All users of this hazardous product should be familiar with manufacturers' recommendations.

Allyl alcohol: Prior to incineration, dilution of this highly toxic liquid with a flammable solvent is recommended. It is miscible with water and most organic solvents. The compound is hazardous to wildlife and is toxic to plants and seeds. It has no lasting effect on soil although temporary sterilization occurs.

Benzene: This flammable liquid burns with a very smoky flame. Dilution with alcohol or acetone is suggested in order to minimize smoke.

Dehydroacetic acid: The acid is a solid which is insoluble in water and moderately soluble in benzene and acetone. The sodium salt is soluble in water but insoluble in most organic solvents.

Endothal: Endothal, a toxic solid compound is not readily degraded by common reagents. It is stable in acid and reacts with bases to form salts. It is stable to about 90°C, at which temperature it is slowly converted to the anhydride. Burial of unwanted quantities has also been suggested.[141]

Ethylene: This gaseous compound is flammable.

Ethylene oxide: Ethylene oxide (b.p. 10.7°C) is flammable and explosive in air at concentrations $> 3\%$. Concentrations of 0.5 to 10% in air will kill most animals in a short time. It is soluble in water. The aqueous solution is fairly stable, but is slowly hydrolyzed to ethylene glycol.[8]

Ethyl formate: Ethyl formate is soluble in 10 parts of water and will slowly hydrolyze to formic acid and ethanol, compounds which are readily biodegradable, and of minimal danger to the environment. Alkali or acid will speed the hydrolysis.

Ethyl hexanediol: This liquid insect repellent has very slight dermal toxicity.

Formaldehyde: Aqueous solutions and dusts containing formaldehyde constitute a serious dermal and inhalation hazard.

Metaldehyde: Metaldehyde is insoluble in water but soluble in acetone or benzene.

2-Propene-1,1-diol diacetate: Soluble in water at 1.8%. Soluble in most organic solvents.

Propylene oxide: Propylene oxide, a fumigant for dried fruit, is a flammable gas, explosive in air between 2.1 and 21.5%.

Sorbic acid: Sorbic acid is a solid compound which has fungicidal and mold and yeast inhibiting properties. It is slightly soluble in water and alcohol, soluble in acetone.[11]

Sodium fluoroacetate: This extremely dangerous rodenticide has a very high oral toxicity (LD_{50} = 0.2 mg/kg) and is also absorbed through unbroken skin. It is extremely hazardous to all wildlife. The pure salt is very soluble in water (insoluble in organic solvents) but is normally used as a bait at low concentrations.

The compound is unstable at temperatures above 110°C and decomposes at 200°C. Thus, careful incineration has been suggested as a disposal procedure by the Manufacturing Chemists Association.[14] According to their procedure, the product should be mixed with large amounts of vermiculite, sodium bicarbonate and sand-soda ash. Slaked lime should also be added to the mixture. Two incineration procedures for this mixture are suggested. The best of these procedures is to burn the mixture in a closed incinerator equipped with an afterburner and an alkali scrubber. The other procedure suggests that the mixture be covered with scrap wood and paper in an open incinerator. (The incinerator should be lighted by means of an excelsior train.)

Organic Compounds, > 9 Carbon Atoms

The compounds in this group have a wide range of uses and properties, but do not in general have the volatility or extremely acute toxicity of some of the compounds in the < 9 carbon atom group.

Anthraquinone
Benzyl benzoate
Biphenyl
Butoxypolypropylene glycol
Butyl mesityl oxide oxalate
Chlorflurenol
Creosote
n-Decanol
Di-n-butyl phthalate
Dimethyl phthalate
Griseofulvin
2-Isovaleryl-1,3-indandione
Methoprene
Methyl nonyl ketone
MGK Repellent 11®
Naphthalene
Naphthaleneacetic acid
1,8-Naphthalic anhydride
β-Naphthoxyacetic acid
Orthophenylphenol
Petroleum oils
Tabutrex®
Trimedlure

Methods for the disposal of pesticides in this group are similar to those described for pesticides containing 1-8 carbon atoms. Incineration is the most generally useful method (see preceding section).

The following is a list of pesticides in this group with information concerning suggested solvents for incineration and comments concerning special disposal hazards.

Anthraquinone: Anthraquinone, a relatively nontoxic, solid, bird repellent is applied to seeds. It is only slightly soluble in water and organic solvents. It is not very hazardous to wildlife.[93]

Benzyl benzoate: Benzyl benzoate is formulated as a flammable solution (alcohol). It is an insecticide for scabies and lice on human beings and pet animals. It has very low dermal toxicity (although it can cause dermal irritation).

Biphenyl: Biphenyl is a relatively nontoxic fungicide which is ordinarily impregnated on fruit wraps which should be combustible.

Butoxypolypropylene glycol: This relatively nontoxic insect repellent is a colorless liquid soluble in most organic solvents including kerosene. It is no longer of major commercial interest.[8]

Butyl mesityl oxide oxalate: This liquid insect repellent is formulated as an oily mixture containing 60% dimethyl phthalate and 20% ethylhexanediol. The mixture has very low oral and dermal toxicity and is combustible.

Chlorflurenol: Chlorflurenal, a solid herbicide, is soluble in acetone and methyl alcohol. The emulsifiable concentrate is flammable. Preliminary experiments indicate complete breakdown in soil,[5] thus, burial of small quantities would not cause excessive harm to the environment. Furthermore, the compound is highly susceptible to degradation by light.[5]

Creosote: Creosote, a brown-black liquid is toxic, although precise LD_{50} amounts are not available. It is flammable and soluble in kerosene and other organic solvents. The product is very toxic to plants.

Di-n-butyl phthalate: This oily liquid is an insect repellent. It is nonpoisonous and generally nonirritating to man.

Dimethyl phthalate: Dimethyl phthalate is an oily liquid which can be used directly as an insect repellent (it is also incorporated into insect repellent creams).

Methoprene: The manufacturer of this insect growth regulator states that the product is very nonpersistent and of no hazard to wildlife. They suggest disposal by burial, but, if permissible, the product could be burned.

2-Isovaleryl-1,3-indandione: This solid insecticide is insoluble in water, but soluble in most common organic solvents.

MGK Repellent 11®: This liquid insect repellent is used for the treatment of dairy cattle. It is formulated as a spray containing pyrethrum.

Naphthalene: Naphthalene is a solid flammable compound which is used for the control of clothes moths. Fumes from this compound can damage the eyes and irritate mucous membranes and skin. The product is very phytotoxic and 10 ppm in water is lethal to fish.

Naphthalene acetic acid: Naphthalene acetic acid is a solid compound which is used as a growth regulator and is sold as a dilute (less than 1%) aqueous solution. The methyl ester and the sodium salt have the same toxicity and are also used as plant growth regulators. (The sodium salt is marketed as a powder containing 3.5%.) There are no reported hazards to wildlife.67/

β-Naphthoxyacetic acid: β-Naphthoxyacetic acid, a plant growth regulator, is insoluble in water but soluble in alcohol.

Orthophenyl phenol: Orthophenyl phenol, a solid fungicide, is insoluble in water but soluble in methanol. It is reported to have no hazard to wildlife.67/

Petroleum oils: Several types of petroleum oils have been used for pest control. All of these are combustible and can be disposed by burning.

Tabutrex®: Tabutrex®, a liquid insect repellent, is miscible with most organic solvents including alcohol. It has relatively very low dermal toxicity.

Trimedlure: This liquid is an insect attractant, insoluble in water, soluble in organic solvents.

Anticoagulants

Four rodenticides are used which have anticoagulant activity.

Diphacinone
Fumarin®
Pival®
Warfarin

These four compounds are closely related in chemical structure. They are usually sold as baits containing 50-250 ppm. (Concentrates will contain as much as 5,000 ppm.) Incineration of warfarin is recommended,14/ and would also be suitable for diphacinone and fumarin.

SECTION VIII

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APPENDIX A

PESTICIDES AND PESTICIDE CONTAINERS--REGULATIONS FOR ACCEPTANCE AND RECOMMENDED PROCEDURES FOR DISPOSAL

Federal Register, Vol. 39, No. 85--Wednesday, May 1, 1974

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

PART 165—REGULATIONS FOR THE ACCEPTANCE OF CERTAIN PESTICIDES AND RECOMMENDED PROCEDURES FOR THE DISPOSAL AND STORAGE OF PESTICIDES AND PESTICIDES CONTAINERS

The previous Federal pesticide legislation, the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (7 U.S.C. 135 et seq.), known as FIFRA, did not address the problems of disposal or storage. However, the Federal Environmental Pesticide Control Act of 1972 (PL 92-516, 86 Stat. 973) alters and broadens FIFRA to provide for the first definitive control of pesticide, and pesticide container, disposal and storage. Under section 19(a) of the amended Act, the Administrator of the Environmental Protection Agency is required to "establish procedures and regulations for the disposal or storage of packages and containers of pesticides and for disposal or storage of excess amounts of such pesticides, and accept at convenient locations for safe disposal a pesticide the registration of which is canceled under section 6(c) if requested by the owner of the pesticide." The regulations for acceptance, and recommended procedures for disposal and storage, contained herein represent the Agency's first issuance in accordance with the provisions of section 19(a) of the new Act.

The potential seriousness of health and environmental hazards due to improper disposal and storage of pesticides and containers became increasingly clear in the late 1960's, as documented case studies accumulated. Expanding usage of pesticides in the United States (an estimated 665 million pounds in 1968) and increasing numbers of spent containers requiring disposal (240 million in 1968, up 50 percent over the number in 1963) indicated that these problems could be expected to increase. Since little was known of the extent of the problem, or of proper methods of disposal and storage, the Working Group on Pesticides, composed of experts from several Federal departments, was asked to study the subject. Their initial recommendations were published under the title "Summary of Interim Guidelines for Disposal of Surplus Waste Pesticides and Pesticide Containers." More recently, in 1972 a Task Force on Excess Chemicals, with representation from all parts of the Environmental Protection Agency, was formed to study disposal problems relating to pesticides and other hazardous chemicals, and to recommend solutions.

In drafting these regulations and recommended procedures the Agency drew heavily on the knowledge and information developed by these two groups, other Federal and State agencies and departments, and the private sector. Thus, these documents represent a broadly-based judgment regarding the pesticide and container disposal and storage requirements necessary to protect the environment. Compliance is achievable using available technology; however, facilities utilizing this technology are not readily available to the general public in all geographic areas at the present time.

Among the new features of the Act is the requirement that the Administrator of the Environmental Protection Agency accept at convenient locations for safe disposal a pesticide the registration of which is canceled under section 6(c) if requested by the owner of the pesticide. Section 6(c) of the new Act refers only to those pesticides the registrations of which have been canceled after first having been suspended to prevent imminent hazards during the time required for cancellation proceedings. The owner of such a pesticide is required to make a formal request in writing to the appropriate Regional Administrator; upon approval of the request, mutually convenient arrangements will be made for acceptance. Since pesticides finally canceled under section 6(c) are not subject to a grandfather clause, pesticides canceled under the FIFRA prior to October 21, 1972, will not qualify. Other canceled pesticides which do not qualify under the conditions set forth in section 6(c) of the new Act will not be accepted pursuant to section 19(a) of the new Act, and their safe storage or disposal is the responsibility of the owner.

The recommended disposal procedures apply to all pesticides and pesticide-related wastes, including those which are or may in the future be registered for general use or restricted use, or used under an experimental use permit. Additionally, they also apply to full containers, spent or used containers, and container residues. Fur packages and containers of pesticides intended for use in the home and garden or on farms and ranches when single containers are to be disposed of, the Agency does not require that disposal procedures be followed. Such disposal will have only minimal environmental impact and is preferable to concentrating these products and containers.

The storage criteria and procedures apply to all pesticides, pesticide-related wastes and contaminated containers which are classed as "highly toxic" or "moderately toxic," according to EPA's classification system for pesticides. The storage of pesticides and their containers which are in the mildly toxic category is judged not to present any undue hazards to public health or the environment and, therefore, is excluded from these criteria and procedures. The temporary storage of limited quantities of pesticides in the other categories, if undertaken at environmentally safe sites, is also excluded.

In considering disposal techniques, first preference should be given to procedures designed to recover some useful value from excess pesticides and containers. Where large quantities are involved, one of the first recommendations is that the excess material should be used for the purpose originally intended, provided this use is legal. Another alternative is to return the material to the manufacturer for potential reuse or reprocessing. A third alternative, in some cases, may be the export of the material to countries where its use is desired and legal.

Should these alternatives be inapplicable, the ultimate disposal method should be determined by the type of material. Organic pesticides which do not contain mercury, lead, cadmium, or arsenic may be disposed of by incineration at temperatures which will ensure complete destruction. Maximum volume reduction is achieved by incineration, and the incinerator emissions can be treated so that only relatively innocuous products are emitted. Incineration is not, however, applicable to those organic pesticides which contain heavy metals such as mercury, lead, cadmium, or arsenic, nor is it applicable to most inorganic pesticides or metallo-organic pesticides which have not been treated for removal of heavy metals.

If incineration is not applicable or available, disposal in specially designated landfills is suggested as an alternative. However, encapsulation prior to landfilling is recommended for certain materials such as those containing mercury, lead, cadmium, and arsenic, and inorganic compounds which are highly mobile in the soil. Encapsulation of these will retard mobility and contain them within a small area which can be permanently marked and recorded for future reference. Properly rinsed pesticide containers, however, may be reused or recycled as scrap or safely disposed of in a sanitary landfill; rinse liquids which cannot be used should be disposed of as if they were an excess pesticide. Among the disposal procedures not recommended are water dumping, open dumping, and open burning, except that open burning of small quantities of certain containers, and open field burial of single containers on farms and ranches by the pesticide user may be acceptable in some areas.

Other disposal processes, such as soil injection, well injection, and chemical degradation, may be acceptable in specific cases. At present, such methods have been neither sufficiently described nor classified to suggest their general use, and further study is necessary.

Storage sites and facilities should be located and constructed to prevent escape of pesticides and contaminated materials into the environment. Where practicable, provision for separate storage of different classifications of pesticides according to their chemical type, and for routine container inspection, should be considered. Special procedures should be followed in case fires or explosions occur where pesticides are stored.

A notice of proposed rulemaking and issuance of procedures was published in the FEDERAL REGISTER (40 CFR Part 165) on May 23, 1973. The Agency invited the submittal of comments by July 23, 1973. Sixty-two letters of comment were received and their suggestions were carefully considered. The several major issues raised, and the results of the Agency's consideration of them, follow.

The largest number of commenters questioned the appropriateness of the proposed 500 lb. exclusion from the recommended storage procedures, on the basis that there are variations in the hazards of different pesticides. They pointed out that a few pounds of one kind can, in certain cases, represent a greater hazard than several thousand pounds of another kind. The Agency concluded that the 500 lb. exclusion was unrealistic and that the storage recommendations should be keyed to a rating system that would consider the overall hazard of the pesticide and would be readily apparent to even untrained personnel. It was decided to adopt the current EPA toxicity rating system for pesticide labeling. Under that system the following signal words are required on labels:

Category	*Signal words/symbol required on labels*
Highly toxic........	DANGER, POISON, Skull and Crossbones.
Moderately toxic....	WARNING.
Slightly toxic.......	CAUTION.

Pesticides in the first two classes, highly toxic and moderately toxic, and which have the corresponding signal words or symbol on the container label, will be covered by the recommended storage criteria and procedures. Other pesticides, including most of those registered for use in the home and garden, represent a lower degree of hazard, and will not be covered.

Several requests for temporary storage exemptions from the recommended storage criteria and procedures were made, for example, by commercial pesticide applicators operating in remote areas where availability or construction of recommended facilities is impractical. These requests were resolved in two ways. First, the hazard rating system for recommended storage procedures will exclude many of the pesticides normally used. Second, temporary storage for a single application's amount has been provided for at isolated and secured sites where the less stringent criteria and procedures will not increase the potential for environmental pollution.

The statement that "* * * these disposal procedures are mandatory only for the Agency * * *" caused the Environmental Defense Fund to question the appropriateness of the promulgation of disposal and storage recommended procedures instead of regulations, in view of the FIFRA as amended wording on this subject. However, adequate disposal sites and the necessary facilities are not readily available nationwide, and significant information gaps exist which make it infeasible to write specific criteria for certain disposal methods and procedures. Further, information on the full extent of environmental damages and of the economic impact of such regulations is lacking. Therefore, the Agency has retained the recommended procedures approach. At such time as this information has been obtained and analyzed, consideration will be given to proposing comprehensive regulations relative to storage and disposal.

The merit in the comments above derives from the potential for considerable environmental damage caused by acts such as water dumping, open dumping, open burning, inadequately controlled well injection, and storage next to food and feed. Consideration of these comments has led the Agency to begin drafting a new proposed rulemaking to prohibit or further constrain certain disposal and storage practices, and possibly to change procedures based on updated information as it becomes available. It is expected that this proposed rulemaking will be published in 1974.

Although section 12 of the new Act makes unlawful distribution, shipment or receiving for delivery of an unregistered or canceled pesticide, the Agency interprets section 19 as authorizing the movement of such pesticides for the specific purposes of disposal or storage.

Several commenters were concerned that there were no provisions for reuse or recycle as scrap of noncombustible containers. The recommended triple rinsing procedure will clean Group II containers sufficiently well so that insignificant contamination occurs when such containers are legally refilled with another pesticide belonging to the same chemical class. Triple rinsing also prepares containers for crushing or shredding and recycle as scrap. Provisions for this resource conservation step have been included in § 165.9(b), and specifically require that adequate rinsing be undertaken before such reuse or recycle.

Besides these major revisions, several minor wording changes were made which did not significantly change the direction or scope of the recommended procedures.

It is hoped that these regulations and recommended procedures will alert all Federal, State and local government agencies and private manufacturers, handlers, and users of pesticides to the need for proper disposal and storage of excess pesticides, pesticide containers and pesticide-related wastes. The United States Environmental Protection Agency will follow these recommended procedures in its own operations. Each office, laboratory or other facility of the Agency will conform strictly to these procedures in the disposal or storage of pesticides and their containers. State and local agencies are cautioned against adoption of these recommended procedures as regulations without careful study of the environmental and economic factors applicable to their own situations, including the availability of disposal sites and facilities.

These regulations and recommended procedures for disposal and storage of pesticides and pesticide containers are issued under the authority of sections 19(a) and 25(a) of the Federal Insecticide, Fungicide, and Rodenticide Act as amended by the Federal Environmental Pesticide Control Act of 1972 (86 Stat. 955, 977), and section 204 of the Solid Waste Disposal Act (P.L. 89-272, as amended by P.L. 91-512).

RUSSELL E. TRAIN,
Administrator.

APRIL 24, 1974.

Subpart A—General

Sec.
165.1 Definitions.
165.2 Authorization and scope.

Subpart B—Acceptance Regulations

165.3 Acceptable pesticides.
165.4 Request for acceptance.
165.5 Delivery.
165.6 Disposal.

Subpart C—Pesticides and Containers Recommended Procedures

165.7 Procedures not recommended.
165.8 Recommended procedures for the disposal of excess pesticides.
165.9 Recommended procedures for the disposal of pesticide containers and residues.
165.10 Recommended procedures and criteria for the storage of pesticides and pesticide containers.

Subpart D—Pesticide-Related Waste Recommended Procedures

165.11 Procedures for disposal and storage of pesticide-related waste.

AUTHORITY: Secs. 19(a) and 25(a) of the Federal Insecticide, Fungicide, and Rodenticide Act as amended by the Federal Environmental Pesticide Control Act of 1972 (86 Stat. 955, 977), and sec. 204 of the Solid Waste Disposal Act (Pub. L. 89-272 as amended by Pub. L. 91-512).

Subpart A—General

§ 165.1 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them by the Act.

(a) "The Act" means the Federal Insecticide, Fungicide, and Rodenticide Act as amended by the Federal Environmental Pesticide Control Act of 1972 (Pub. L. 92-516, 86 Stat. 973).

(b) "Agency" means the U.S. Environmental Protection Agency.

(c) (1) "Administrator" means the Administrator of the Agency, or any officer or employee thereof to whom authority has been heretofore delegated or to whom authority may hereafter be delegated, to act in his stead.

(2) "Regional Administrator" means the Administrator of a Regional Office of the Agency or his delegatee.

(d) "Adequate storage" means placing of pesticides in proper containers and in safe areas as per § 165.10 as to minimize the possibility of escape which could result in unreasonable adverse effects on the environment.

(e) "Complete destruction" of pesticides means alteration by physical or chemical processes to inorganic forms.

(f) "Container" means any package, can, bottle, bag, barrel, drum, tank, or other containing-device (excluding spray applicator tanks) used to enclose a pesticide or pesticide-related waste.

(g) "Decontamination/detoxification" means processes which will convert pesticides into nontoxic compounds.

(h) "Degradation products" means those chemicals resulting from partial decomposition or chemical breakdown of pesticides.

(i) "Diluent" means the material added to a pesticide by the user or manufacturer to reduce the concentration of active ingredient in the mixture.

(j) "Encapsulate" means to seal a pesticide, and its container if appropriate, in an impervious container made of plastic, glass, or other suitable material which will not be chemically degraded by the contents. This container then should be sealed within a durable container made from steel, plastic, concrete, or other suitable material of sufficient thickness and strength to resist physical damage during and subsequent to burial or storage.

(k) "Heavy metals" means metallic elements of higher atomic weights, including but not limited to arsenic, cadmium, copper, lead, mercury, manganese, zinc, chromium, tin, thallium, and selenium.

(l) "Imminent hazard" means a situation which exists when the continued use of a pesticide during the time required for cancellation proceedings would be likely to result in unreasonable adverse effects on the environment or will involve unreasonable hazard to the survival of a species declared endangered by the Secretary of the Interior under Public Law 91-135.

(m) "Ocean dumping" means the disposal of pesticides in or on the oceans and seas, as defined in P. L. 92-532.

(n) "Open burning" means the combustion of a pesticide or pesticide container in any fashion other than incineration.

(o) "Open dumping" means the placing of pesticides or containers in a land site in a manner which does not protect the environment and is exposed to the elements, vectors, and scavengers.

(p) "Pesticide" means (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

(1) "Excess pesticides" means all pesticides which cannot be legally sold pursuant to the Act or which are to be discarded.

(2) "Organic pesticides" means carbon-containing substances used as pesticides, excluding metallo-organic compounds.

(3) "Inorganic pesticides" means non-carbon-containing substances used as pesticides.

(4) "Metallo-organic pesticides" means a class of organic pesticides containing one or more metal or metalloid atoms in the structure.

(q) "Pesticide-related wastes" means all pesticide-containing wastes or by-products which are produced in the manufacturing or processing of a pesticide and which are to be discarded, but which, pursuant to acceptable pesticide manufacturing or processing operations, are not ordinarily a part of or contained within an industrial waste stream discharged into a sewer or the waters of a state.

(r) "Pesticide incinerator" means any installation capable of the controlled combustion of pesticides, at a temperature of 1000°C (1832°F) for two seconds dwell time in the combustion zone, or lower temperatures and related dwell times that will assure complete conversion of the specific pesticide to inorganic gases and solid ash residues. Such installation complies with the Agency Guidelines for the Thermal Processing of Solid Wastes as prescribed in 40 CFR Part 240.

(s) "Safe disposal" means discarding pesticides or containers in a permanent manner so as to comply with these proposed procedures and so as to avoid unreasonable adverse effects on the environment.

(t) "Sanitary landfill" means a disposal facility employing an engineered method of disposing of solid wastes on land in a manner which minimizes environmental hazards by spreading the solid wastes in thin layers, compacting the solid wastes to the smallest practical volume, and applying cover material at the end of each working day. Such facility complies with the Agency Guidelines for the Land Disposal of Solid Wastes as prescribed in 40 CFR Part 241.

(u) "Scrubbing" means the washing of impurities from any process gas stream.

(v) "Soil injection" means the emplacement of pesticides by ordinary tillage practices within the plow layer of a soil.

(w) "Specially designated landfill" means a landfill at which complete long term protection is provided for the quality of surface and subsurface waters from pesticides, pesticide containers, and pesticide-related wastes deposited therein, and against hazard to public health and the environment. Such sites should be located and engineered to avoid direct hydraulic continuity with surface and subsurface waters, and any leachate or subsurface flow into the disposal area should be contained within the site unless treatment is provided. Monitoring wells should be established and a sampling and analysis program conducted. The location of the disposal site should be permanently recorded in the appropriate local office of legal jurisdiction. Such facility complies with the Agency Guidelines for the Land Disposal of Solid Wastes as prescribed in 40 CFR Part 241.

(x) "Triple rinse" means the flushing of containers three times, each time using a volume of the normal diluent equal to approximately ten percent of the container's capacity, and adding the rinse liquid to the spray mixture or disposing of it by a method prescribed for disposing of the pesticide.

(y) "Unreclaimable residues" means residual materials of little or no value remaining after incineration.

(z) "Water dumping" means the disposal of pesticides in or on lakes, ponds, rivers, sewers, or other water systems as defined in P. L. 92-500.

(aa) "Well injection" means disposal of liquid wastes through a hole or shaft to a subsurface stratum.

§ 165.2 *Authorization and scope.*

(a) The regulations in this part and recommended procedures are published pursuant to sections 19(a) and 25(a) of the Act, which give the Administrator the authority to establish regulations and procedures for the disposal or storage of packages and containers of pesticides, and for disposal or storage of excess amounts of such pesticides, and require the Administrator to accept for safe disposal a pesticide the registration of which is canceled under section 6(c) of the Act if requested by the owner of the pesticide. Section 165.11 of these recommended procedures (Pesticide-Related Wastes) is published pursuant to Section 204 of the Solid Waste Disposal Act (P.L. 89-272 as amended by P.L. 91-512) which authorizes the Administrator to make information available and to make recommendations concerning the disposal and handling of wastes.

(b) Regulations for acceptance for safe disposal of pesticides canceled under section 6(c) and recommended proceprocedures for disposal or storage of pesticides, pesticide containers, and pesticide-related wastes are those which the Administrator judges as necessary, with an adequate margin of safety, to protect public health and the environment. Such procedures are subject to addition and revision as the Administrator deems necessary.

(c) The recommended procedures for the disposal of pesticides and pesticide containers apply to all pesticides, pesticide-related wastes (and their containers) including those which are or may in the future be registered for general use or restricted use, or covered under an experimental use permit, except those single containers discussed in paragraph (e), of this section. These disposal procedures are mandatory only for the Agency in carrying out its pesticide and container disposal operations.

(d) The recommended procedures and criteria for the storage of pesticides and pesticide containers apply to all pesticides and excess pesticides and to used empty containers and containers which contain pesticides. These procedures and criteria apply to sites and facilities where pesticides that are classed as highly toxic or moderately toxic, and bear the signal words DANGER, POISON, or WARNING, or the skull and crossbones symbol, on the label are stored. Pesticides covered by an experimental use permit should also be stored in accordance with these procedures. These storage procedures are mandatory only for the Agency in carrying out its pesticide and container storage operations. Temporary storage by the user of the quantity of pesticide needed for a single application may be undertaken in isolated areas in accordance with the procedures and criteria given in § 165.10(a).

(e) Recommended pesticide and pesticide container disposal procedures shall not apply to containers of pesticides registered for use in the home and garden if securely wrapped in several layers of paper and disposed of singly during routine municipal solid waste disposal, nor to containers of pesticides used on farms and ranches where disposal by open-field burial of single containers is undertaken with due regard to the protection of surface and sub-surface waters.

(f) As a general guideline, the owner of excess pesticides should first exhaust the two following avenues before undertaking final disposal:

(1) Use for the purposes originally intended, at the prescribed dosage rates, providing these are currently legal under all Federal, State, and local laws and regulations.

(2) Return to the manufacturer or distributor for potential re-labelling, recovery of resources, or reprocessing into other materials. Transportation must be in accordance with all currently applicable U.S. Department of Transportation regulations, including those prescribed in 49 CFR Parts 170–179 and 397, 46 CFR Part 146, and 14 CFR Part 103. The "for hire" transportation of unregistered pesticides across state lines may be subject to the Interstate Commerce Commission's economic regulations (49 U.S.C. 1 et seq. for rail carriers; 306, 307, and 309 for motor carriers; and 909 for domestic water carriers), and the Commission should be contacted in case of doubt.

NOTE: Some excess pesticides may be suitable for export to a country where use of the pesticide is legal. All pesticides so exported should be in good condition and packed according to specifications of the foreign purchaser, and must be transported to the port of embarkation in accordance with all Department of Transportation regulations. All shipments should be in conformance with section 17(a) of the Act.

(g) To provide documentation of actual situations, all accidents or incidents involving the storage or disposal of pesticides, pesticide containers, or pesticide-related wastes should be reported to the appropriate Regional Administrator.

Subpart B—Acceptance Regulations

§ 165.3 Acceptable pesticides.

The Administrator will accept for safe disposal those pesticides the registrations of which have been canceled, after first having been suspended to prevent an imminent hazard during the time required for cancellation proceedings as specified in section 6(c) of the Act. However, no other pesticides will be accepted pursuant to section 19(a) of the Act, and nothing herein shall obligate the Federal Government to own or operate any disposal facility.

§ 165.4 Request for acceptance.

(a) Before the owner of such a pesticide requests acceptance by the Administrator for disposal, he shall make every reasonable effort to return the material to either its manufacturer, distributor, or to another agent capable of using the material.

(b) If such an effort is unsuccessful, the following procedure shall be used by the owner of a suspended pesticide to request acceptance by the Administrator:

(1) The owner of such a pesticide must make a formal request for acceptance, in writing, to the Regional Administrator for the area where such pesticides are located.

(2) Records and data pertaining to the amount, location, physical form, type and condition of containers, and date of manufacture or purchase of individual lots must be submitted. Certification that the owner of the suspended pesticide has made every reasonable effort to return the material to the manufacturer, distributor of the pesticide, or to other agents capable of re-labeling, recovering, recycling or reprocessing the material and has been refused on the basis of technological infeasibility, must also be submitted.

§ 165.5 Delivery.

If it is found that a canceled pesticide meets the requirements for acceptance, the Regional Administrator will confer with the owner for purposes of arranging a mutually convenient location for acceptance of individual lots of such canceled pesticides. Transportation to the acceptance location will be the responsibility of, and transportation costs will be borne by, the owner of the pesticide.

§ 165.6 Disposal.

Following such acceptance, the Regional Administrator will cause the disposal or storage of such pesticide as appropriate, in accordance with the procedures outlined in subparts A and C of this part.

Subpart C—Pesticides and Containers

§ 165.7 Procedures not recommended.

No person should dispose of or store (or receive for disposal or storage) any pesticide or dispose of or store any pesticide container or pesticide container residue:

(a) In a manner inconsistent with its label or labeling.

(b) So as to cause or allow open dumping of pesticides or pesticide containers.

(c) So as to cause or allow open burning of pesticides or pesticide containers; except, the open burning by the user of small quantities of combustible containers formerly containing organic or metallo-organic pesticides, except organic mercury, lead, cadmium, or arsenic compounds, is acceptable when allowed by State and local regulations.

(d) So as to cause or allow water dumping or ocean dumping, except in conformance with regulations developed pursuant to the National Marine Protection, Research and Sanctuaries Act of 1972 (Pub. L. 92-532), and to Sections 304, 307, and 311 of the Federal Water Pollution Control Act as Amended (Pub. L. 92-500).

(e) So as to violate any applicable Federal or State pollution control standard.

(f) So as to violate any applicable provisions of the Act.

§ 165.8 Recommended procedures for the disposal of pesticides.

Recommended procedures for the disposal of pesticides are given below:

(a) Organic pesticides, (except organic mercury, lead, cadmium, and arsenic compounds which are discussed in paragraph (c) of this section) should be disposed of according to the following procedures:

(1) Incinerate in a pesticide incinerator at the specified temperature/dwell time combination, or at such other lower temperature and related dwell time that will cause complete destruction of the pesticide. As a minimum it should be verified that all emissions meet the requirements of the Clean Air Act of 1970 (42 U.S.C. 1857 et seq.) relating to gaseous emissions: specifically any performance regulations and standards promulgated under sections 111 and 112 should be adhered to. Any liquids, sludges, or solid residues generated should be disposed of in accordance with all applicable Federal, State, and local pollution control requirements. Municipal solid waste incinerators may be used to incinerate excess pesticides or pesticide containers provided they meet the criteria of a pesticide incinerator and precautions are taken to ensure proper operation.

(2) If appropriate incineration facilities are not available, organic pesticides may be disposed of by burial in a specially designated landfill. Records to locate such buried pesticides within the landfill site should be maintained.

(3) The environmental impact of the soil injection method of pesticide disposal has not been clearly defined nationally, and therefore this disposal method should be undertaken only with specific guidance. It is recommended that advice be requested from the Regional Administrator in the region where the material will be disposed of prior to undertaking such disposal by this method.

(4) There are chemical methods and procedures which will degrade some pesticides to forms which are not hazardous to the environment. However, practical methods are not available for all groups of pesticides. Until a list of such methods is available, it is recommended that advice be requested from the Regional Administrator in the region where the material will be disposed of prior to undertaking disposal by such method.

(5) If adequate incineration facilities, specially designated landfill facilities, or other approved procedures are not available, temporary storage of pesticides for disposal should be undertaken. Storage facilities, management procedures, safety precautions and fire and explosion control procedures should conform to those set forth in § 165.10.

(6) The effects of subsurface emplacement of liquid by well injection and the fate of injection materials are uncertain with available knowledge, and could result in serious environmental damage requiring complex and costly solutions on a long-term basis. Well injection should not be considered for pesticide disposal unless all reasonable alternative measures have been explored and found less satisfactory in terms of environmental protection. As noted in the Administrator's Decision Statement No. 5, dated February 6, 1973, the Agency's policy is to oppose well injection of fluid pesticides

"without strict controls and a clear demonstration that such emplacement will not interfere with present or potential use of the subsurface environment, contaminate ground water resources or otherwise damage the environment." Adequate pre-injection tests, provisions for monitoring the operation and the environmental effects, contingency plans to cope with well failures, and provisions for plugging injection wells when abandoned should be made. The Regional Administrator should be advised of each operation.

(b) Metallo-organic pesticides (except organic mercury, lead, cadmium, or arsenic compounds which are discussed in paragraph (c) of this section), should be disposed of according to the following procedures:

(1) After first subjecting such compounds to an appropriate chemical or physical treatment to recover the heavy metals from the hydrocarbon structure, incinearate in a pesticide incinerator as described in paragraph (a)(1) of this section.

(2) If appropriate treatment and incineration are not available, bury in a specially designated landfill as noted in paragraph (a)(2) of this section.

(3) Disposal by soil injection of metallo-organic pesticides should be undertaken only in accordance with the procedure set forth in paragraph (a)(3) of this section.

(4) Chemical degradation methods and procedures that can be demonstrated to provide safety to public health and the environment should be undertaken only as noted in paragraph (a)(4) of this section.

(5) If adequate disposal methods as listed above in this section are not available, the pesticides should be stored according to the procedures in § 165.10 until disposal facilities become available.

(6) Well injection of metallo-organic pesticides should be undertaken only in accordance with the procedures set forth in paragraph 165.8(a)(6) of this section.

(c) Organic mercury, lead, cadmium, arsenic, and all inorganic pesticides should be disposed of according to the following procedures:

(1) Chemically deactivate the pesticides by conversion to non-hazardous compounds, and recover the heavy metal resources. Methods that are appropriate will be described and classified according to their applicability to the different groups of pesticides. Until a list of practical methods is available, however, each use of such procedures should be undertaken only as noted in paragraph 165.8(a)(4) of this section.

(2) If chemical deactivation facilities are not available, such pesticides should be encapsulated and buried in a specially designated landfill. Records sufficient to permit location for retrieval should be maintained.

(3) If none of the above options is available, place in suitable containers (if necessary) and provide temporary storage until such time as adequate disposal facilities or procedures are available. The general criteria for acceptable storage are noted in § 165.10.

§ 165.9 Recommended procedures for the disposal of pesticide containers and residues.

(a) *Group I Containers.* Combustible containers which formerly contained organic or metallo-organic pesticides, except organic mercury, lead, cadmium, or arsenic compounds, should be disposed of in a pesticide incinerator, or buried in a specially designated landfill, as noted in § 165.8(a); except that small quantities of such containers may be burned in open fields by the user of the pesticide when such open burning is permitted by State and local regulations, or buried singly by the user in open fields with due regard for protection of surface and sub-surface water.

(b) *Group II Containers.* Non-combustible containers which formerly contained organic or metallo-organic pesticides, except organic mercury, lead, cadmium, or arsenic compounds, should first be triple-rinsed. Containers in good condition may then be returned to the pesticide manufacturer or formulator, or drum reconditioner for reuse with the same chemical class of pesticide previously contained providing such reuse is legal under currently applicable U.S. Department of Transportation regulations including those set forth in 49 CFR 173.28. Other rinsed metal containers should be punctured to facilitate drainage prior to transport to a facility for recycle as scrap metal or for disposal. All rinsed containers may be crushed and disposed of by burial in a sanitary landfill, in conformance with State and local standards or buried in the field by the user of the pesticide. Unrinsed containers should be disposed of in a specially designated landfill, or subjected to incineration in a pesticide incinerator.

(c) *Group III Containers.* Containers (both combustible and noncombustible) which formerly contained organic mercury, lead, cadmium, or arsenic or inorganic pesticides and which have been triple-rinsed and punctured to facilitate drainage, may be disposed of in a sanitary landfill. Such containers which are not rinsed should be encapsulated and buried in a specially designated landfill.

(d) *Residue disposal.* Residues and rinse liquids should be added to spray mixtures in the field. If not, they should be disposed of in the manner prescribed for each specific type of pesticide as set forth in § 165.8.

§ 165.10 Recommended procedures and criteria for storage of pesticides and pesticide containers.

(a) *General.* (1) Pesticides and excess pesticides and their containers whose uncontrolled release into the environment would cause unreasonable adverse effects on the environment should be stored only in facilities where due regard has been given to the hazardous nature of the pesticide, site selection, protective enclosures, and operating procedures, and where adequate measures are taken to assure personal safety, accident prevention, and detection of potential environmental damages. These storage procedures and criteria should be observed at sites and facilities where pesticides and excess pesticides (and their containers) that are classed as highly toxic or moderately toxic and are required to bear the signal words DANGER, POISON, or WARNING, or the skull and crossbones symbol on the label are stored. These procedures and criteria are not necessary at facilities where most pesticides registered for use in the home and garden, or pesticides classed as slightly toxic (word CAUTION on the label) are stored. All facilities where pesticides which are or may in the future be covered by an experimental use permit or other special permit are stored should be in conformance with these procedures and criteria.

(2) Temporary storage of highly toxic or moderately toxic pesticides for the period immediately prior to, and of the quantity required for a single application, may be undertaken by the user at isolated sites and facilities where flooding is unlikely, where provisions are made to prevent unauthorized entry, and where separation from water systems and buildings is sufficient to prevent contamination by runoff, percolation, or wind-blown particles or vapors.

(b) *Storage sites.* Storage sites should be selected with due regard to the amount, toxicity, and environmental hazard of pesticides, and the number and sizes of containers to be handled. When practicable, sites should be located where flooding is unlikely and where soil texture/structure and geologic/hydrologic characteristics will prevent the contamination of any water system by runoff or percolation. Where warranted, drainage from the site should be contained (by natural or artificial barriers or dikes), monitored, and if contaminated, disposed of as an excess pesticide as discussed in § 165.8. Consideration should also be given to containing wind-blown pesticide dusts or particles.

(c) *Storage facilities.* Pesticides should be stored in a dry, well ventilated, separate room, building or covered area where fire protection is provided. Where relevant and practicable, the following precautions should be taken:

(1) The entire storage facility should be secured by a climb-proof fence, and doors and gates should be kept locked to prevent unauthorized entry.

(2) Identification signs should be placed on rooms, buildings, and fences to advise of the contents and warn of their hazardous nature, in accordance with suggestions given in paragraph (g)(1)(i) of this section.

(3) All items of movable equipment used for handling pesticides at the storage site which might be used for other purposes should be labeled "contaminated with pesticides" and should not be removed from the site unless thoroughly decontaminated.

(4) Provision should be made for decontamination of personnel and equipment such as delivery trucks, tarpaulin covers, etc. Where feasible, a wash basin, and shower with a delayed-closing pull

chain valve should be provided. All contaminated water should be disposed of as an excess pesticide. Where required, decontamination area should be paved or lined with impervious materials, and should include gutters. Contaminated runoff should be collected, and treated as an excess pesticide.

(d) *Operational procedures*. Pesticide containers should be stored with the label plainly visible. If containers are not in good condition when received, the contents should be placed in a suitable container and properly relabeled. If dry excess pesticides are received in paper bags that are damaged, the bag and the contents should be placed in a sound container that can be sealed. Metal or rigid plastic containers should be checked carefully to insure that the lids and bungs are tight. Where relevant and practicable, the following provisions should be considered:

(1) *Classification and separation*. (i) Each pesticide formulation should be segregated and stored under a sign containing the name of the formulation. Rigid containers should be stored in an upright position and all containers should be stored off the ground, in an orderly way, so as to permit ready access and inspection. They should be accumulated in rows or units so that all labels are visible, and with lanes to provide effective access. A complete inventory should be maintained indicating the number and identity of containers in each storage unit.

(ii) Excess pesticides and containers should be further segregated according to the method of disposal to ensure that entire shipments of the same class of pesticides are disposed of properly, and that accidental mixing of containers of different categories does not occur during the removal operation.

(2) *Container inspection and maintenance*. Containers should be checked regularly for corrosion and leaks. If such is found, the container should be transferred to a sound, suitable, larger container and be properly labeled. Materials such as adsorptive clay, hydrated lime, and sodium hypochlorite should be kept on hand for use as appropriate for the emergency treatment or detoxification of spills or leaks. (Specific information relating to other spill treatment procedures and materials will be published as it is confirmed.)

(e) *Safety precautions*. In addition to precautions specified on the label and in the labeling, rules for personal safety and accident prevention similar to those listed below should be available in areas where personnel congregate:

(1) *Accident prevention measures*. (i) Inspect all containers of pesticides for leaks before handling them.

(ii) Do not mishandle containers and thereby create emergencies by carelessness.

(iii) Do not permit unauthorized persons in the storage area.

(iv) Do not store pesticides next to food or feed or other articles intended for consumption by humans or animals.

(v) Inspect all vehicles prior to departure, and treat those found to be contaminated.

(2) *Safety measures*. (i) Do not store food, beverages, tobacco, eating utensils, or smoking equipment in the storage or loading areas.

(ii) Do not drink, eat food, smoke, or use tobacco in areas where pesticides are present.

(iii) Wear rubber gloves while handling containers of pesticides.

(iv) Do not put fingers in mouth or rub eyes while working.

(v) Wash hands before eating, smoking, or using toilet and immediately after loading, or transferring pesticides.

(vi) Persons working regularly with organophosphate and N-alkyl carbamate pesticides should have periodic physical examinations, including cholinesterase tests.

(f) *Protective clothing and respirators*. (1) When handling pesticides which are in concentrated form, protective clothing should be worn. Contaminated garments should be removed immediately, and extra sets of clean clothing should be maintained nearby.

(2) Particular care should be taken when handling certain pesticides to protect against absorption through skin, and inhalation of fumes. Respirators or gas masks with proper canisters approved for the particular type of exposure noted in the label directions, should be used when such pesticides are handled.

(g) *Fire control*. (1) Where large quantities of pesticides are stored, or where conditions may otherwise warrant, the owner of stored pesticides should inform the local fire department, hospitals, public health officials, and police department in writing of the hazards that such pesticides may present in the event of a fire. A floor plan of the storage area indicating where different pesticide classifications are regularly stored should be provided to the fire department. The fire chief should be furnished with the home telephone numbers of (i) the person(s) responsible for the pesticide storage facility, (ii) the appropriate Regional Administrator, who can summon the appropriate Agency emergency response team, (iii) the U.S. Coast Guard, and (iv) the Pesticide Safety Team Network of the National Agricultural Chemicals Association.

(2) *Suggestions for Fire Hazard Abatement*. (i) Where applicable, plainly label the outside of each storage area with "DANGER," "POISON," "PESTICIDE STORAGE" signs. Consult with the local fire department regarding the use of the current hazard signal system of the National Fire Protection Association.

(ii) Post a list on the outside of the storage area of the types of chemicals stored therein. The list should be updated to reflect changes in types stored.

(3) *Suggested Fire Fighting Precautions*. (i) Wear air-supplied breathing apparatus and rubber clothing.

(ii) Avoid breathing or otherwise contacting toxic smoke and fumes.

(iii) Wash completely as soon as possible after encountering smoke and fumes.

(iv) Contain the water used in fire fighting within the storage site drainage system.

(v) Fireman should take cholinesterase tests after fighting a fire involving organophosphate or N-alkyl carbamate pesticides, if they have been heavily exposed to the smoke. Baseline cholinesterase tests should be part of the regular physical examination for such firemen.

(vi) Evacuate persons near such fires who may come in contact with smoke or fumes or contaminated surfaces.

(h) *Monitoring*. An environmental monitoring system should be considered in the vicinity of storage facilites. Samples from the surroundng ground and surface water, wildlife, and plant environment, as appropriate, should be tested in a regular program to assure minimal environmental insult. Analyses should be performed according to "Official Methods of the Association of Official Analytical Chemists (AOAC)," and such other methods and procedures as may be suitable.

Subpart D—Pesticide-Related Wastes

§ 165.11 Procedures for disposal and storage of pesticide-related wastes.

(a) In general all pesticide-related wastes should be disposed of as excess pesticides in accordance with the procedures set forth in §§ 165.7 and 165.8. Such wastes should not be disposed of by addition to an industrial effluent stream if not ordinarily a part of or contained within such industrial effluent stream, except as regulated by and in compliance with effluent standards established pursuant to sections 304 and 307 of the Federal Water Pollution Control Act as amended.

(b) Pesticide-related wastes which are to be stored should be managed in accordance with the provisions of § 165.10.

[FR Doc.74-9911 Filed 4-30-74;8:45 am]

APPENDIX B

PESTICIDE PRODUCERS, PLANT SITES AND TELEPHONE NUMBERS

Producer	Telephone
ABBOTT LABORATORIES	312-688-6100
Abbott Park	
North Chicago, Illinois 60064	
Amdal Company (Division of Abbott Laboratories)	312-688-6100
Address same as above	
ACETO CHEMICAL COMPANY, INC.	212-898-2300
126-02 Northern Boulevard	
Flushing, New York 11368	
ALCO STANDARD CORPORATION	125-666-0760
Valley Forge, Pennsylvania 19481	
Miller Chemical and Fertilizer Corp. (Subsidiary of ALCO)	717-637-8921
P.O. Box 33	
Hanover, Pennsylvania 17331	
Plants:	
Frederick, Maryland	301-662-6374
Hanover, Pennsylvania	717-637-8921
Whiteford, Maryland	301-452-8144
Winchester, Virginia	703-662-5563
ALDRICH CHEMICAL COMPANY, INC.	414-273-3850
940 West St. Paul Avenue	
Milwaukee, Wisconsin 53233	
ALLIED CHEMICAL CORPORATION	212-422-7300
1411 Broadway	
New York, New York 10008	
Agricultural Division	212-422-7300
P.O. Box 2061R	
Morristown, New Jersey 07960	
Plant:	
Baltimore, Maryland	301-752-3707
Industrial Chemicals Division	
P.O. Box 1139R	
Morristown, New Jersey 07960	
Plants:	
Baton Rouge, Louisiana	
Hopewell, Virginia	
Semet-Solvay Division	
P.O. Box 1013R	
Morristown, New Jersey 07960	
Plant:	
Detroit, Michigan	
Fairfield, Alabama	
Ironton, Ohio	
ALPHA LABORATORIES, INC.	303-756-1338
1685 South Fairfax	
Denver, Colorado 80222	
AMDAL COMPANY	
(See Abbott Laboratories)	
AMERICAN CYANAMID COMPANY	212-732-9500
Berdan Avenue	
Wayne, New Jersey 07470	
Agricultural Division	609-799-0400
P.O. Box 400	
Princeton, New Jersey 08540	
Plants:	
Warners, New Jersey	609-799-0400
Princeton, New Jersey	201-862-6000
Linden, New Jersey	
AMERICAN SMELTING AND REFINING COMPANY	212-732-9500
120 Broadway	
New York, New York 10005	
Plant:	303-534-6381
Denver, Colorado	303-757-5107
THE ANSUL COMPANY	715-735-7411
1 Stanton Street	
Marinette, Wisconsin 54143	
Eagle River Chemical Corp.	501-572-3701
Highway 242	
West Helena, Arkansas 72390	
ARAPAHOE CHEMICALS DIVISION	
(See Syntex Corporation)	
ASHLAND OIL, INC.	606-329-3333
1409 Winchester Avenue	
Ashland, Kentucky 41101	
Ashland Chemical Company	
P.O. Box 2219	
Columbus, Ohio 43216	
Plant:	
Great Meadows, New Jersey	201-637-4101
BAYCHEM CORPORATION	212-751-5544
425 Park Avenue	
New York, New York 10022	
Chemagro Corporation	816-483-4250
Hawthorn Road	
P.O. Box 4913	
Kansas City, Missouri 64120	

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
BUCKMAN LABORATORIES, INC. 1256 North McLean Boulevard Memphis, Tennessee 38108	
Plants:	
Cadet, Missouri	
Memphis, Tennessee	
CALHIO CHEMICALS, INC. (See Stauffer Chemical Company)	
CHEMICAL FORMULATORS, INC. P.O. Box 26 Nitro, West Virginia	304-755-3374
CHEMPAR CHEMICAL COMPANY, INC. 260 Madison Avenue New York, New York 10016	212-679-4428
Plants:	
Ancramdale, New York	
Portland, Oregon	
CHEVRON CHEMICAL COMPANY (See Standard Oil)	
CHIPMAN CHEMICAL COMPANY (See Rhodia, Inc.)	
CIBA-GEIGY CORPORATION Saw Mill River Road Ardsley, New York 10502	914-478-3131
CIBA Agrochemical Division 556 Morris Avenue Summit, New Jersey 07901	201-277-5000
Plants:	
Summit, New Jersey	201-277-5000
McIntosh, Alabama	205-944-2201
St. Gabriel, Louisiana	504-642-5441
CINCINNATI MILACRON, INC. 4701 Marbury Avenue Cincinnati, Ohio 45203	513-554-1554
Cincinnati Milacron Chemicals, Inc. West Street Reading, Ohio 45215	513-554-1554
W. A. CLEARY CORPORATION P.O. Box 749 New Brunswick, New Jersey 08903	201-247-8000
COSAN CHEMICAL CORPORATION 481 River Road Clifton, New Jersey 07013	201-472-4400

Producer	Telephone
CPC INTERNATIONAL, INC. Arbor Street Sewaren, New Jersey 07077	
S. B. Penick and Company, Division 100 Church Street New York, New York 10007	
Plants:	
Lyndhurst, New Jersey	
Montville, New Jersey	
DIAMOND SHAMROCK CORPORATION 300 Union Commerce Building Cleveland, Ohio 44115	216-621-6100
Diamond Shamrock Chemical Company Address as above	216-621-6100
Plants:	
Atlanta, Illinois	217-648-2311
Greens Bayou, Texas	713-453-7146
Curtis Bay, Maryland	301-789-8800
DOW CHEMICAL COMPANY, USA Midland, Michigan 48640	517-636-1000
Plants:	
Freeport, Texas	714-238-2011
Midland, Michigan	517-636-1000
Pittsburg, California	415-432-7311
E. I. DU PONT DE NEMOURS AND COMPANY, INC. Industrial and Biochemicals Department Du Pont Building Wilmington, Delaware 19898	302-774-1000
Plants:	
Belle, West Virginia	304-949-4313
East Chicago, Indiana	219-398-2040
La Porte, Texas	713-471-2771
Grasselli, New Jersey	201-862-1500
Linden, New Jersey	
EAGLE RIVER CHEMICAL CORPORATION (See Ansul Company)	
ELANCO PRODUCTS COMPANY (See Eli Lilly)	
FAIRMONT CHEMICAL COMPANY, INC. 117 Blanchard Street Newark, New Jersey 07105	

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
FERRO CORPORATION	216-641-8580
One Erieview Plaza	
Cleveland, Ohio	
Agricultural Chemicals Division	216-232-4330
4150 East 56th Street	
Cleveland, Ohio 44105	
Plant:	
Bedford, Ohio	
FIKE CHEMICALS, INC.	304-755-3336
P.O. Box 546	
Nitro, West Virginia 25143	
ELI LILLY AND COMPANY	317-636-2211
740 South Alabama Street	
Indianapolis, Indiana 46206	
Elanco Products Company Division	317-636-2211
(Division of Eli Lilly and Company)	
740 South Alabama Street	
Indianapolis, Indiana 46206	
Plants:	
Lafayette, Indiana	317-474-1430
Indianapolis, Indiana	317-636-2211
FMC CORPORATION	212-687-7400
633 Third Avenue	
New York, New York 10017	
Agricultural Chemical Division	716-735-3761
100 Niagara Street	
Middleport, New York 14105	
Plants:	
Middleport, New York	716-735-3761
Baltimore, Maryland	301-355-6400
Vancouver, Washington	
GAF CORPORATION	212-582-7600
140 West 51st Street	
New York, New York 10020	
Chemical Division	201-862-2600
P.O. Box 12	
Linden, New Jersey 07036	
Plants:	
Texas City, Texas	713-945-3411
Linden, New Jersey	201-862-2600
GORDON CORPORATION	913-342-8780
300 South Third Street	
Kansas City, Kansas 66118	
GREAT LAKES CHEMICAL CORPORATION	317-463-2511
Highway 52, North West	
West Lafayette, Indiana 47906	
Plant:	
El Dorado, Arkansas	501-862-5141
GULF OIL CORPORATION	412-391-2400
Gulf Building	
P.O. Box 1166	
Pittsburgh, Pennsylvania 15230	
Gulf Oil Chemicals Company	412-391-2400
P.O. Box 1166	
Pittsburgh, Pennsylvania 15230	
Plant:	
Galena, Kansas	316-783-1321
HALBY PRODUCTS COMPANY, INC.	
(See Witco Chemical Corporation)	
HARDWICKE CHEMICAL COMPANY	
(See McLaughlin Gormley King Company)	
HERCULES INCORPORATED	302-656-9811
910 Market Street	
Wilmington, Delaware 19899	
Plants:	
Brunswick, Georgia	912-265-3550
Plaquemine, Louisiana	504-687-6311
Burlington, New Jersey	609-584-6411
Hattiesburg, Mississippi	601-584-6411
HOOKER CHEMICAL CORPORATION	
(See Occidental Petroleum Corporation)	
IMPERIAL, INC.	712-246-2150
West 6th and Grass Streets	
Shenandoah, Iowa 51601	
KERR-MCGEE CORPORATION	405-236-1313
Kerr-McGee Building	
Oklahoma City, Oklahoma 73102	
Kerr-McGee Chemical Corporation	
Address as above	
Plants:	
Hamilton, Mississippi	601-343-8311
Los Angeles, California	213-385-3356
KOPPERS COMPANY, INC.	412-391-3300
Koppers Building	
Pittsburgh, Pennsylvania 15219	
Organic Materials Division	
Address as above	
Plants:	
Cicero, Illinois	
Follansbee, West Virginia	
Fontana, California	
Houston, Texas	
Kearny, New Jersey	
Portland, Oregon	
St. Paul, Minnesota	
Woodward, Alabama	
Youngstown, Ohio	

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
LONZA, INC.	201-791-7500
22-10 Route 208	
Fair Lawn, New Jersey 07410	
Plant:	
Mapleton, Illinois	309-697-5400
MALLINCKRODT CHEMICAL WORKS	314-231-8980
Second and Mallinckrodt Streets	
P.O. Box 5439	
St. Louis, Missouri 63160	
Plants:	
Raleigh, North Carolina	919-876-1500
St. Louis, Missouri	314-231-8980
Jersey City, New Jersey	201-432-2500
MCLAUGHLIN GORMLEY KING COMPANY	612-331-1808
1715 Fifth Street, South East	
Minneapolis, Minnesota 55414	
Hardwicke Chemical Company	803-438-3471
(Subsidiary of McLaughlin, etc.)	
Route 2, Box 50A	
Elgin, South Carolina 29045	
MERCK AND COMPANY, INC.	201-381-5000
126 East Lincoln Avenue	
Rahway, New Jersey 07065	
Plants:	
Danville, Pennsylvania	717-275-2220
Hawthorne, New Jersey	201-391-5000
MICHIGAN CHEMICAL CORPORATION	
(See Northwest Industries, Inc.)	
MILLER CHEMICAL AND FERTILIZER CORPORATION	
(See Alco Standard Corporation)	
MILLMASTER ONYX CORPORATION	212-687-2757
99 Park Avenue	
New York, New York 10016	
Millmaster Chemical Company	212-687-2757
Address same as above	
Plant:	
Berkeley Heights, New Jersey	201-464-1200
MOBIL OIL COMPANY	212-883-4242
150 East 42nd Street	
New York, New York 10017	
Mobil Chemical Company	703-644-7611
P.O. Box 677	
Richmond, Virginia 23206	
Industrial Chemicals Division	703-644-7611
801 East Main Street	
Richmond, Virginia 23208	
Plant:	
Charleston, South Carolina	803-554-1280
Mt. Pleasant, Tennessee	

Producer	Telephone
MONSANTO COMPANY	314-694-1006
800 North Lindbergh Boulevard	
St. Louis, Missouri 63166	
Monsanto Chemical Products Company	314-694-1000
Address same as above	
Plants:	
Anniston, Alabama	205-236-6381
Luling, Louisiana	504-784-6263
Muscatine, Iowa	319-263-0093
Nitro, West Virginia	304-755-3341
St. Louis, Missouri	314-694-1000
Sauget, Illinois	618-397-4815
MONTROSE CHEMICAL CORPORATION OF CALIFORNIA	213-328-5462
2021 Normandie	
Torrance, California	
Montrose Chemical Company	
(Division of Chris Chraft Industries)	
Plant:	
Newark, New Jersey 07105	201-344-7662
MOONEY CHEMICALS, INC.	
2301 Scranton Road	
Cleveland, Ohio 44113	
Plant:	
Franklin, Pennsylvania	
MOTOMCO, INC.	
89 Terminal Avenue	
Clark, New Jersey 07066	
M&T CHEMICALS, INC.	203-552-3784
(Subsidiary of American Can Company)	
American Lane	
Greenwich, Connecticut	
Plant:	
Carrollton, Kentucky	502-732-4411
NEASE CHEMICALS, INC.	814-238-2424
P.O. Box 221	
State College, Pennsylvania 16801	
Plants:	
Fernald, Ohio	513-738-1891
Salem, Ohio	216-332-1561
State College, Pennsylvania	814-238-2424
NIAGARA CHEMICAL DIVISION	
(See FMC Corporation)	
NIKLOR CHEMICAL COMPANY, INC.	213-830-2252
2060 East 220th Street	
Long Beach, California 90810	
NOR-AM AGRICULTURAL PRODUCTS, INC.	312-621-6700
20 North Wacker Drive	
Chicago, Illinois 60606	

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
NORTH AMERICAN PHILIPS CORPORATION	
100 East 42nd Street	
New York, New York 10017	
PEPI, Inc., Subsidiary	
Thompson-Hayward Chemical Company, Subsidiary	913-321-3131
5200 Speaker Road	
P.O. Box 2383	
Kansas City, Kansas 66110	
Plants:	
Brea, California	
Kansas City, Kansas	
New Oreleans, Louisiana	
NORTHWEST INDUSTRIES, INC.	312-263-4200
400 West Madison Street	
Chicago, Illinois 60611	
Michigan Chemical Corporation	312-828-9500
(Subsidiary of Northwest Industries)	
351 East Ohio Street	
Chicago, Illinois 60611	
Plant:	
St. Louis, Michigan	517-681-1241
Velsicol Chemical Corporation	312-467-5700
(Subsidiary of Northwest Industries)	
341 East Ohio Street	
Chicago, Illinois 60611	
Plants:	
Bayport, Texas	713-474-2861
Chattanooga, Tennessee	
Marshall, Illinois	217-826-2321
Memphis, Tennessee	901-324-4401
OCCIDENTAL PETROLEUM CORPORATION	213-879-1700
10889 Wilshire Boulevard	
Los Angeles, California 90024	
Hooker Chemical Corporation, Subsid.	716-285-6655
1515 Summer Street	
Stamford, Connecticut 06905	
Plant:	
Niagara Falls, New York	
OLIN CORPORATION	203-356-2000
120 Long Ridge Road	
Stamford, Connecticut 06904	
Agricultural Chemicals Division	501-376-2471
P.O. Box 991	
Little Rock, Arkansas 72203	
Industrial Products and Services Division	
120 Long Ridge Road	
Stamford, Connecticut 06904	
Plants:	
McIntosh, Alabama	
Houston, Texas	713-526-2761
Rochester, New York	

Producer	Telephone
ORTHO DIVISION	
(See Standard Oil Company of California)	
PENNWALT CORPORATION	
Three Parkway, Pennwalt Building	
Philadelphia, Pennsylvania 19102	
Plant:	
Wyandotte, Michigan	313-285-9200
PFIZER, INC.	212-573-2323
235 East 42nd Street	
New York, New York 10017	
Chemicals Division	919-292-1781
2210 High Point Road	
Greensboro, North Carolina 27402	
PHILLIPS PETROLEUM COMPANY	918-336-6600
Bartlesville, Oklahoma 74004	
Plant:	
Phillips, Texas	806-273-2831
PPG INDUSTRIES, INC.	412-434-2252
One Gateway Center	
Pittsburgh, Pennsylvania 15222	
Industrial Chemical Division	412-434-2252
Address same as above	
Plant:	
Barberton, Ohio	216-753-4561
REGIS CHEMICAL COMPANY	312-967-6000
1101 North Franklin Street	
Morton Grove, Illinois 60610	
REICHHOLD CHEMICALS, INC.	
RCI Building	
White Plains, New York 10602	
Plant:	
Tacoma, Washington	
RIVERDALE CHEMICAL COMPANY	312-756-2010
220 East 17th Street	
Chicago Heights, Illinois 60411	
RHODIA, INC.	212-753-4850
600 Madison Avenue	
New York, New York 10022	
Chipman Division	201-816-7700
120 Jersey Avenue	
New Brunswick, New Jersey 08903	
Plant:	
Portland, Oregon	503-226-6221

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
ROHM AND HAAS COMPANY	215-592-3000
Independence Mall West	
Philadelphia, Pennsylvania 19105	
Plants:	
Bristol, Pennsylvania	215-788-5501
Philadelphia, Pennsylvania	215-533-2000
RORER-AMCHEM	215-628-1000
Fort Washington, Pennsylvania 19034	
Amchem Products, Inc.	215-628-1000
Brookside Avenue	
P.O. Box 33	
Ambler, Pennsylvania 19002	
Plants:	
Ambler, Pennsylvania	215-628-1000
Clinton, Ohio	
Fremont, California	
St. Joseph, Missouri	816-238-0692
SELNEY COMPANY, INC.	
(See Sonbert Chemical Company)	
SHELL CHEMICAL COMPANY	713-220-4867
1 Shell Plaza	
Houston, Texas 77002	
Agricultural Division	415-837-1531
2401 Crow Canyon Road	
San Ramon, California 94583	
Plants:	
Denver, Colorado	303-288-1561
Mobile, Alabama	
Industrial Chemicals Division	
P.O. Box 2463	
Houston, Texas 77001	
Plants:	
Deer Park, Texas	713-479-2311
Norco, Louisiana	
SOBIN CHEMICALS, INC.	617-288-5100
Sobin Park	
Boston, Massachusetts 02210	
Plant:	
Orrington, Maine	
SONBERT CHEMICAL COMPANY, INC.	212-788-0020
185 Court Street	
Brooklyn, New York 11201	
The Selney Company, Inc.	212-596-1061
(Subsidiary of Sonbert Chemical)	
Seven Park Avenue	
New York, New York 10016	

Producer	Telephone
SONFORD CHEMICAL COMPANY	713 - no listing
Pure-Atlantic Highway	
Port Neches, Texas 77651	
STANDARD OIL COMPANY OF CALIFORNIA	
CALIFORNIA WESTERN OPERATIONS	
Chevron Chemical Company	415-434-0515
200 Bush	
San Francisco, California 94104	
Ortho Division (of Chevron)	415-235-9301
940 Hensley Street	
Richmond, California 94804	
Plants:	
Fort Madison, Iowa	319-372-6012
Maryland Heights, Missouri	314-432-8234
Orlando, Florida	305-295-0451
Perry, Ohio	
Richmond, California	415-235-9300
South Plainfield, New Jersey	201-757-1400
STAUFFER CHEMICAL COMPANY	212-421-5000
299 Park Avenue	
New York, New York 10017	
Agricultural Chemicals Division	212-421-5000
Address same as above	
Plants:	
Ardsley, New York	914-693-1200
Cold Creek (Bux), Alabama	205-675-0950
Henderson, Nevada	702-565-8781
Mt. Pleasant, Tennessee	615-379-3257
Richmond, California	415-233-9361
Calhio Chemicals, Inc.	
(Subsidiary of Stauffer Chemical)	
P.O. Box 86	
Perry, Ohio 44081	
STERLING DRUG INCORPORATED	212-972-4141
90 Park Avenue	
New York, New York 10016	
Winthrop Laboratories	212-972-4141
(Division of Sterling Drug)	
Address same as above	
Plant:	
Rensselaer, New York	
SYNTEX CORPORATION	415-855-5050
3401 Hillview Avenue	
Palo Alto, California 94304	
Arapahoe Chemicals Division	
(Division of Syntex)	
Plant:	
Boulder, Colorado	303-442-1926

PESTICIDE PRODUCERS (Continued)

Producer	Telephone
TENNECO CHEMICALS, INC. 300 East 42nd Street New York, New York 10017	212-761-3900
Tenneco Intermediate Division 5 Turner Place P.O. Box 2 Piscataway, New Jersey 08854	201-752-5000
Plants: Elizabeth, New Jersey Long Beach, California	
Fords, New Jersey	201-442-0271
THOMPSON-HAYWARD CHEMICAL COMPANY (See North American Philips Corporation)	
TRANSVAAL, INC. Marshall Road P.O. Box 69 Jacksonville, Arkansas 72076	501-982-2132
TROY CHEMICAL CORPORATION One Avenue L Newark, New Jersey 07105	201-589-2500
TULL CHEMICAL CORPORATION 130 Burton Street P.O. Box 3246 Oxford, Alabama 36203	205-831-1154
UNION CARBIDE CORPORATION Chemicals and Plastics Division 270 Park Avenue New York, New York 10017	212-551-2345
Plants:	
Institute, West Virginia	304-747-0001
South Charleston, West Virginia	304-747-0001
UNIROYAL, INC. 1230 Avenue of the Americas New York, New York 10020	212-247-5060
Uniroyal Chemical Division Spencer Street Naugatuck, Connecticut 06770	203-729-5241
Plants:	
Gastonia, North Carolina	704-864-3411
Geismar, Louisiana	504-673-6181
Naugatuck, Connecticut	203-729-5241
U. S. BORAX AND CHEMICAL CORPORATION 3075 Wilshire Boulevard Los Angeles, California 90010	
Plant: Columbus, Mississippi (Joint venture with Hooker Chemical Corporation)	
UNITED STATES STEEL CORPORATION 600 Grant Street Pittsburgh, Pennsylvania 15230	
USS Chemicals, Division Address same as above	
Plants: Clairton, Pennsylvania Fairfield, Alabama Gary, Indiana	
UPJOHN COMPANY Tuco Division 7171 Portage Road Kalamazoo, Michigan 49001	616-382-4000
R. T. VANDERBILT COMPANY, INC. 230 Park Avenue New York, New York 10017	212-686-6864
Vanderbilt Chemical Corporation Address same as above	212-686-6864
Plant:	
Bethel, Connecticut	203-744-3900
VELSICOL CHEMICAL CORPORATION (See Northwest Industries, Inc.)	
VENTRON CORPORATION Congress Street Beverly, Massachusetts 01915	617-922-1875
Chemicals Division 1645 South Kilbourn Avenue Chicago, Illinois 60609	312-521-7000
Plant:	
Wood Ridge, New Jersey	201-939-4600
VICKSBURG CHEMICAL COMPANY P.O. Box 3 Vicksburg, Mississippi 39180	
VINELAND CHEMICAL COMPANY West Wheat Road P.O. Box 745 Vineland, New Jersey 08360	609-691-3535
VIRGINIA CHEMICALS, INC. 3340 West Norfolk Road Portsmouth, Virginia 23703	703-484-5000

PESTICIDE PRODUCERS (Concluded)

Producer	Telephone
VULCAN MATERIALS COMPANY P.O. Box 7497 Birmingham, Alabama 35223 Chemicals Division P.O. Box 545 Wichita, Kansas 67201	316-524-4211
WHITE CHEMICAL CORPORATION P.O. Box 278 Bayonne, New Jersey 07002	201-437-0050
WINTHROP LABORATORIES (See Sterling Drugs, Inc.)	
WITCO CHEMICAL CORPORATION 277 Park Avenue New York, New York 10017	
Halby Division 600 Terminal Avenue New Castle, Delaware 19720	302-656-5428
Plant: Wilmington, Delaware	302-655-3337

APPENDIX C

ESTIMATED U.S. PESTICIDE PRODUCTION VOLUME, 1971[13]

A. Herbicides (Including Defoliants and Plant Growth Regulators)

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.[a]
Atrazine	Aatrex	Ciba-Geigy	90
2,4-D	Several	Several	45
MSMA-DSMA	Several	Several	35
Sodium chlorate	Several	Several	30
Trifluralin	Treflan	Elanco	25
Propachlor	Ramrod	Monsanto	23
Chloramben	Amiben	Amchem	20
Alachlor	Lasso	Monsanto	20
CDAA	Randox	Monsanto	10
Bromacil	Hyvar	Du Pont	8
Diuron	Karmex	Du Pont	6
Propanil	Rogue; Stam F34	Monsanto; Rohm & Haas	6
Butylate	Sutan	Stauffer	6
2,4,5-T	Several	Several	6
N.A.	DEF	Chemagro	5
EPTC	Eptam	Stauffer	5
Simazine	Princep	Ciba-Geigy	5
Dalapon	Dowpon	Dow	5
Fluometuron	Cotoran	Ciba-Geigy	4
Propazine	Milogard	Ciba-Geigy	4
Maleic hydrazide	Several	Several	3
Dinoseb (DNBP)	Premerge	Dow	3
Diphenamid	Dymid, Enide	Elanco, Upjohn	3
N.A.	Folex	Mobil	3
Silvex	Several	Several	3
Picloram	Tordon	Dow	3
Cacodylic acid	Several	Ansul	2
Nitralin	Planavin	Shell	2
Dicamba	Banvel-D	Velsicol	2
Vernolate	Vernam	Stauffer	2
Naptalam	Alanap	Uniroyal	2
Linuron	Lorox	Du Pont	2
Norea	Herban	Hercules	2
TBA	Trysben	Du Pont	2
DCPA	Dacthal	Diamond	2

A. Herbicides (Including Defoliants and Plant Growth Regulators) (Concluded)

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.[a]
Endothall	Aquathol	Pennwalt	2
Chlorpropham (CIPC)	Several	PPG	2
Subtotal, 37 herbicides of > 1 MM lb production volume each			398
All other herbicides			30
Total, All Herbicides			428

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a/ MM = million; A.I. = active ingredient.

B. Synthetic Organic Insecticides, Miticides, Nematocides

Common Name	Trade Name	Chemical Group[a]	Principal Manufacturer	Production MM lb A.I.
Carbaryl	Sevin	CA	Union Carbide	55
Toxaphene	Several (incl. Strobane-T	CH	Hercules, Tenneco	50
DDT	Several	CH	Montrose	45
Methyl parathion	Several	OP	Monsanto	45
Malathion	Cythion	OP	American Cyanamid	30
Chlordane	Several	CH	Velsicol	25
Parathion	Several	OP	Monsanto	15
Aldrin	Several	CH	Shell	10
Methoxychlor	Several	CH	Du Pont	10
Diazinon	Spectracide	OP	Ciba-Geigy	10
Carbofuran	Furadan	CA	FMC	8
Disulfoton	Di-Syston	OP	Chemagro	8
Phorate	Thimet	OP	American Cyanamid	8
Heptachlor	Several	CH	Velsicol	6
N.A.	Bux	CA	Chevron	6
Monocrotophos	Azodrin	OP	Shell	5
N.A.	Dursban	OP	Dow	5
Dicofol	Kelthane	CH	Rohm & Haas	4
Azinphos-methyl	Guthion	OP	Chemagro	4
Fensulfothion	Dasanit	OP	Chemagro	4
Methomyl	Lannate	CA	Du Pont	2
N.A.	Dyfonate	OP	Stauffer	2
Ethion	Nialate	OP	FMC	2
Ronnel	Korlan	OP	Dow	2
Carbophenothion	Trithion	OP	Stauffer	2
Naled	Dibrom	OP	Chevron	2
Dimethoate	Cygon	OP	American Cyanamid	2
Aldicarb	Temik	CA	Union Carbide	2
Endosulfan	Thiodan	CH	FMC	2
Chlorobenzilate	Several	CH	Ciba-Geigy	2
Crufomate	Ruelene	OP	Dow	2
Subtotal, 31 insecticides of > 1 MM lb production volume each				374
All other synthetic organic insecticides, miticides, nematocides				19
Total, All Synthetic Organic Insecticides, Miticides, Nematocides				393

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[a] CH = chlorinated hydrocarbon.
OP = organophosphate.
CA = carbamate.

C. Botanical, Biological, and Inorganic Insecticides; Attractants, Repellants and Synergists

Common Name	Trade Name	Type Product	Principal Manufacturer	Production MM lb A.I.
Botanical and Biological Insecticides				
Bacillus thuring.	Dipel		Abbott, Nutrilite, IMC	1
Polyhedr. virus	Viron H		IMC	< 1
Pyrethrins	Several		FMC, MGK	< 1
Rotenone	Several		Several	< 1
Nicotine	Black Leaf		Chem. Form.	< 1
Inorganic Insecticides				
PB-arsenate	Several		Several	6
Ca-arsenate	Several		Several	2
Attractants, Repellants, Synergists				
DEET	Several	Rep.	Several	1
Piperonyl butoxide	Several	Syn.	FMC	1
Ethyl hexandiol	6-12	Rep.	Union Carbide	< 1
N.A.	MGK-326	Rep.	MGK	< 1
Trimedlure	N.A.	Att.	Universal Oil	< 1
N.A.	MGK-264	Syn.	MGK	< 1
Heliotropin acetal	Tropital	Syn.	MGK	< 1
Other Attractants, Repellants, Synergists				< 1
Total, All Products				13
Special Category				
Petroleum oils including synthetic spray oils, deodorized kerosene, and other petroleum distillates used as diluents and carriers. Includes herbicidal weed oils and insecticidal dormant spray oils.				a/

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a/ No data available; possibly 1 billion pounds or more.

D. Fungicides

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.
PCP and salts	Several	Several	46[a]
Dithiocarbamates	Several	Several	40[b]
TCP and salts	Several	Dow	20
Captan	Orthocide	Stauffer, Chevron	18
PCNB	Several	Olin	3
Dodine	Cyprex	American Cyanamid	2
Captafol	Difolatar	Chevron	2
Folpet	Phaltan	Stauffer, Chevron	2
Cu-naphthenates	Several	Several	2
Subtotal, 9 listed fungicides > 1 MM lb production volume each			135
All other synthetic organic fungicides			10
Total, all Above Products			145
Inorganic Sulfur and Sulfides			150
Inorganic Copper Salts			2[d]
Total, all Fungicides			297

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[a] Includes use as herbicide, desiccant, molluscicide and for termite control (see Table III).

[b] Includes Dithane M-45®, Dithane S-31®, Ferbam, Nameb, Metham, Nabam, Niacide®, PETD, Polyram®, Zineb and Ziram and Thiram used as pesticide.

[c] Fungicidal use only. Total sales for use as disinfectant and bacteriostat are said to be 4 MM lb per year.

[d] Published data are extremely variable, e.g., 45 MM lb in Ref. 2.

E. Rodenticides, Molluscicides, Fumigants, Soil Conditioners, etc.

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.
Rodenticides			
Warfarin	Several	Several	12
Dipacinone	Diphacin	Nease	< 1
Norbormide	Raticate	Pitman-Moore	< 1
Pindone	Pival	Several	< 1
ANTU	Several	Penick	< 1
Na-fluoracetate	Several	Aceto	< 1
Molluscicides			
Metaldehyde	Several	Comm. Solvents	< 1
Fumigants (Soil, Stored Product, Structural, and Household)			
Methyl bromide	Several	Several	22
DBCP	Several	Several	10
Other acyclic organics			
dichloro-propene-propane mixtures	D-D, Nemex, Vidden D, Telone	Dow, Shell	63[a]
carbon disulfide	Several	Several	
carbon tetrachloride			
ethylene dichloride-dibromide			
chloropicrin			
formaldehyde			
and others			
p-Dichlorobenzene	Several	Several	60[b]
Napthalene	Several	Several	14[a]
Inorganic fumigants	Several	Several	5
Soil Conditioners			
Polyacrylonitrile	N.A.	American Cynamide	10
Other soil conditioners			
Total, all Rodenticides, Molluscicides, Fumigants, Soil Conditioners, etc.			200

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[a] Excludes nonfumigant use.

[b] Includes moth-proofing and lavatory-space deodorant use.

F. Wood Preservatives

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.
Coal and Oil Products			
Creosote			1,000
Petroleum			500
Coal tar			150
Total			1,650
Synthetic Organics and Inorganics			
Pentachlorophenol			[a]
Chromated salts			11.5[b]
Other salts			1.0
Total			12.5

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[a] 25 million pounds included under fungicides.

[b] Various chromated salts also contain copper, arsenic, zinc and fluoride. Est. 3.2 million chromate calculated as $Na_2Cr_2O_7 \cdot 2H_2O$. (Includes small amounts used principally as fire retardant.)

G. Principal Imported Synthetic Organic Pesticides

Common Name	Trade Name	Principal Manufacturer	Production MM lb A.I.
Diquat dibromide			1
Paraquat (dichloride and bis methyl sulfate)			3
Malathion			0.5
Fenitrothion (Sumithion®)			1

APPENDIX D

TRADE AND BRAND NAMES OF SELECTED MAJOR PESTICIDES MARKETED

Insecticides Name	Formulation[a]	Active Ingredient[b]
AAtrex®	4 EC; 80 W8	Atrazine
Acaraben®	90% T; EC	Chlorobenzilate
Alanap®	2 L; 10 Gr.	Naptalam
Aldrin	4 EC; 20 G	Aldrin
Amiben®	2 L; 10 Gr.	Chloramben
Ammate®	P; S	AMS (ammonium sulfamate)
Aquathol®	S; Gr.	Endothall
Aqualin®	L	Acrolein
Azodrin®	3.2 and 5 WML	Azodrin® (monocrotophos)
Banvel-D®	4 S (oil or H_2O); 5, 10 Gr	Dicamba
Belt®	P	Chlordane
Benlate®	50 WP	Benomyl
Bladex®	80 WP	Bladex®
Bux®	2 EC; 10 G	Bux® Ten (metalkamate)
Carbon disulfide	L (with carbon tetrachloride)	Carbon disulfide
Chlordane	EC	Chlordane
CIPC, (Chloro-IPC®)	4 EC; 10, 20 G; D	Chlorpropham
Cotoran®	80 WP	Fluometuron
Cygon®	EC; WP; G	Dimethoate
Cyprex®	65 WP	Dodine
Cythion®	57% EC	Malathion
2,4-D	EC, L, T, Gr.	2,4-D
Dacthal®	75 WP, 5 Gr.	DCPA
Dasanit®	6 EC; 15 G	Fensulfothion
D-D®	L	D-D®
DDT	75% WP	DDT
DEF®	6 EC	DEF®
Dibrom®	L; D	Naled
Difolatan®	4 F	Difolatan® (captafol)
p-Dichlorobenzene	Crystals; Solns.	Paradichlorobenzene
Di-Syston®	L; G	Disulfoton
Dowpon®	85% SP, Conc., Mixtures	Dalapon
DSMA	S, SP	DSMA
Dymid®	L, WP, Gr.	Diphenamid
Dursban®	4 EC; G	Chlorpyrifos
Dyfonate®	4 EC; 20 G	Dyfonate®
Enide®	4 L; 50, 80 WP; 5 Gr.	Diphenamid
Eptam	6 EC; 10 Gr.	EPTC
Folex®	6 EC	Folex® (merphos)
Furadan®	2-10 G; 4 F	Carbofuran

Insecticides Name	Formulation[a/]	Active Ingredient[b/]
Goldcrest®	72% L	Chlordane
Guthion®	50 WP; 2 EC	Azinphosmethyl
Heptachlor	EC; WP; D; Oil Solution	Heptachlor
Herban®	WP	Norea
Hyvar®	80 WP; 2 S; 10 P	Bromacil
Karathane®	WP; Conc.; D	Karathane® (dinocap)
Karmex®	80 WP, 2.8 S	Diuron
Kelthane®	EC; WP	Dicofol
Korlan®	EC; WP; G	Ronnel
Lasso®	4 EC; 10 Gr.	Alachlor
Lannate®	SP	Methomyl
Lorox®	10 Gr; 50 WP	Linuron
Machete®	5 EC; 5 Gr.	Butachlor
Marlate®	EC; WP; D	Methoxychlor
MH-30®	L; S.	MH® (maleic hydrazide)
Milogard®	80 WP	Propazine
Moxie®	EC; WP; D	Methoxychlor
MSMA	6-8S	MSMA
Orthocide	WP; D	Captan
Paraquat	2 L	Paraquat
PCP	S; EC	PCP (pentachlorophenol)
Penta	S; EC	PCP (pentachlorophenol)
Phaltan	50 WP; D	Folpet
Planavin®	4 L; 75 WP	Nitralin
Premerge®	EC; Oil S	Dinoseb (DNBP)
Princep®	80 WP; L; Gr.	Simazine
Ramrod®	65 WP; 20 Gr.	Propachlor
Randox®	4 EC; 20 Gr.	CDAA
Reglone®	2 L	Diquat
Rogue®	EC	Propanil
Ruelene®	EC	Crufomate
Sevin®	80 WP; 50 D	Carbaryl
Silvex	EC	Silvex
Sinox®	EC, S	Dinoseb (DNBP)
Sodium chlorate	G; (with borate)	Sodium chlorate
Spectracide®	EC; WP; G; D; L	Diazinon
Stam F 34	EC	Propanil
2,4,5-T	EC	2,4,5-T

Insecticides Name	Formulation[a]	Active Ingredient[b]
Temik®	10 G	Aldicarb
Thimet®	10 G; L	Phorate
Toxaphene	90% L; 20 D; 40 WP; 4-8 EC	Toxaphene
Trysben®	2 S	2,3,6-TBA
Vernam®	6 EC; 10 Gr.	Vernolate
Warfarin	Bait; 0.54% Soln.	Warfarin
Zerlate	76; 96 WP	Ziram

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[a] Formulations are in units of: pounds active ingredient per gallon for liquids (L); solutions (S); emulsifiable concentrates (EC) and flowables (F); and percent for wettable powders (WP); granules (Gr); dusts (D); soluble powders (SP); concentrates (Conc.); pellets (P); and technical materials (T); unless otherwise noted.

[b] First entry is the name used as the prime entry in the cross-index of this report. Second entry is alternate or proposed new common name.

APPENDIX E

COMMERCIALLY AVAILABLE MIXTURES OF ACTIVE INGREDIENT

This appendix lists commercially available mixtures of pesticides which contain two or more active ingredients. The list was adapted from a longer listing, "Commercial Pesticides Listed According to Uses and Active Ingredients" given in the Pesticide Handbook - Entoma.[12] The products are grouped according to type of pesticide (e.g., fungicide, herbicide, etc.) and subgrouped according to method of application or in a few cases according to specific type (e.g., dusts, sprays, desiccants, repellants, etc.). Within each subgroup, the individual products are listed in alphabetical order according to the active ingredients present: a formulation which contains copper and rotenone would be entered under copper, and not rotenone. Concentrations of components in each mixture may vary between manufacturers or for the application intended and may be changed occasionally as discussed on page 15. A compilation of the exact composition of all available mixtures is far beyond the scope of the present project (in many instances, our reference source[12] did not give the actual composition of the mixture). The present list contains over 500 combinations of pesticides and the total number of "mixed" products actually on the market may be twice as large and new mixtures are frequently being made available. The original list also contains additional groups such as adjuvants, diluents and solvents, antibiotics, and animal repellents that are not included here.

I. Fungicides

A. Dusts

Aluminum Power, Dieldrin, Thiram
Captan, Pentachloronitrobenzene
Carbaryl, Zinc Ethylene Bisdithio-Carbamate
Cycloheximide, Pentachloronitrobenzene
Cycloheximide, Thiram
Dyrene, Maneb, Zinc

B. Sprays

Acrolein
N-Alkyl Dimethyl Benzyl Ammonium Chlorides and N-Di-Alkyl
  Methyl Benzyl Ammonium Chlorides
Auramine, Cadmium Sebacate, Malachite Green, Potassium Chromate,
  Thiram
Auramine, Cadmium Succinate, Malachite Green
Auramine, Crystal Violet, Malachite Green
Cadmium Carbonate, Captan, Pentachloronitrobenzene
Cadmium Chloride Hydrate, Thiram
Captan, Streptomycin
Captan, Zineb
Dinocap, Dodine
Dinocap, Dodine, Monocrotophos
2,2-Dithiobisbenzothiazole, Manganous Benzothiazyl Mercaptide,
  Manganous Dithiocarbamate, Thiram
Dodine, Glyodin
Malachite Green, Phenyl Mercury Dimethyl Dithiocarbamate,
  Thiram
Mercuric Chloride, Mercurous Chloride
Mercury, Thiram
Pentachloronitrobenzene, Thiram
Phenylmercuric Acetate, Thiram
Pine Oil, Iodine
Sodium Dimethyldithiocarbamate, Sodium 2-Mercapto-Benzothiazole
Sodium Polysulfide, Sodium Thiosulfate
Tribromo Salicylanilide, Trifluoromethyl Salicylanilide
Trichloromethyl Thiadiazole, Pentachloronitrobenzene

II. Fungicide-Insecticide

A. Dusts

Aldrin, Captan, Chlordane, DDT, Lindane, Pentachloronitrobenzene
Aldrin, Organic Mercury
BHC (Gamma), Carbaryl, Folpet
BHC (Gamma), Carbaryl, Maneb, Sulfur
BHC (Gamma), 1-1-Bis(Chlorophenyl) 2,2,2-Trichloroethanol, DDT,
  Dinitro, Zineb
BHC (Gamma), DDT, Dicofol, Dinocap
BHC, Dieldrin, Glyodin
BHC (Gamma), DDT, Sulfur
BHC (Gamma), Hexachlorophene, Mercaptobenzothiazole, Oil,
  Propylene, Glycol
BHC (Gamma), Maneb
BHC (Gamma), Methoxychlor, Sulfur
BHC (Gamma) Sulfur
BHC (Gamma), Zineb
Tricalcium Arsenate, Copper
Captan, O,O-Dimethyl S-4-Oxo-1,2,3-Benzotriazin-3-(4-H) XL-
  Methyl Phosphorodithioate
Captan, Carbaryl, Malathion
Captan, Carbophenothion
Captan, Chlordane, Terrachlor
Captan, Karathane, Malathion
Captan, DDT, Dinocap, Malathion
Captan, DDT, Lead Arsenate
Captan, DDT, Malathion, Sulfur
Captan, Dieldrin
Captan, 2-(1-Methylheptyl)-4,6-Dinitrophenyl Crotonate,
  Piperonyl Butoxide, Pyrethrins, Rotenone
Captan, Dinocap, Malathion, Methoxychlor
Captan, Malathion, Methoxychlor
Captan, Malathion, Methoxychlor, Sulfur
Captan, Methoxychlor, Piperonyl Butoxide, Pyrethrins, Rotenoids,
  Rotenone
Captan, Methoxychlor
Captan, Parathion
Captan, Rotenone, Sevin
Captan, Rotenone, Sevin, Zineb
Captan, Sulfur
Captan, Zineb
Carbaryl, Copper

II. Fungicide-Insecticide (Continued)

A. Dusts (Continued)

Carbaryl, Copper, Parathion
Carbaryl, Copper, Sulfur
Carbaryl, Copper, Zinc Chromate
Carbaryl, Dicofol, Dieldrin, Malathion
Carbaryl, Dicofol, Folpet, Malathion
Carbaryl, Malathion, Zineb
Carbaryl, Maneb
Carbaryl, Parathion, Sulfur
Carbaryl, Polyram
Carbaryl, Piperonyl Butoxide, Pyrethrins, Rotenone
Carbaryl, Polyethylene Polymer
Carbaryl, Sulfur
Carbaryl, Sulfur, Zineb
Carbaryl, Zineb
Carbomethoxy-1-Propen-2Yl Dimethyl Phosphate, Sulfur
Chromium, Copper, Zinc Chromate
Coal Tar Oil, Phenols, Soap
Copper, DDT
Copper, DDT, Sulfur
Copper, DDT, Zinc, Chromate
Copper, Methoxychlor, Zinc
Copper Oleate, Lindane, Methoxychlor, 2-(p-tert-Butylphenoxy)
  Isopropyl 2-Chloroethyl Sulfite
Copper, Rotenone
Copper, Rotenoids, Rotenone, Sulfur
Copper, Sulfur, Zinc
Copper, (Unspecified), Malathion, Methoxychlor
Copper, (Unspecified), Manganese, Zinc
Copper, (Unspecified), Methoxychlor
Copper, (Unspecified), Maneb, Parathion
Copper, (Unspecified), Naled, Zinc
Copper, (Unspecified), Parathion
Copper, (Unspecified), Parathion, Sulfur
Copper, (Unspecified), Rotenoids, Rotenone
Copper, (Unspecified), Sulfur
Copper, (Unspecified), TDE
Cuprous Oxide, Sulfur
Dasnit Thiram
DDT, Dinocap, Lindane, Maneb
DDT, Dithane, Parathion

II. Fungicide-Insecticide (Continued)

A. Dusts (Continued)

DDT, Ferbam
DDT, Ferbam, Rotenone, Sulfur
DDT, Hexachlorophene
DDT, Hexachlorophene, Rotenoids, Rotenone
DDT, Maneb, Toxaphene
DDT, Methoxychlor, Oil, Piperonyl Butoxide, Pyrethrins,
  Rotenoids
DDT, Oil, Toxaphene
DDT, Parathion, Zineb
DDT, Polyram
DDT, Rotenone, Zineb
DDT, Sulfur, Toxaphene
DDT, Sulfur
DDT, Zineb
DDT, Ziram
Dichlone, Ferbam, Sulfur
Dichlone, Partathion
Dichloro-6-Chloroanilino-s-Triazine, Malathion
Dicofol, Naled Sulfur
Dieldrin, Sulphur
2,6-Dinitro-6-(2-Octyl) Phenyl Crotonate, Dodine, Phosphamidon
Dinocap, Zineb
Dithane, Sulfur
Endosulfan, Maneb
Endosulfan, Maneb, Rotenone
Endosulfan, Parathion, Zineb
Endosulfan, Zineb
Ferbam, Parathion
Folpet, Naled
Lindane, Methoxychlor, Zineb
Malathion, Methoxychlor, Zineb
Malathion, Sulfur
Malathion, Zineb
Maneb, Methoxychlor
Maneb Parathion
Maneb, TDE
Methoxychlor, Rotenoids, Rotenone, Zineb
Methoxychlor, Zineb
Methoxychlor, Ziram
Naled, Sulfur

II. Fungicide-Insecticide (Continued)

A. Dusts (Concluded)

Parathion, Sulfur
Parathion, Zineb
Pyrethrins, Rotenoids, Rotenone, Sulfur, Zineb
Polyram, Toxaphene
Rotenoids, Rotenone, Zineb
Rotenone, Sulfur
Rotenone, Zineb
Sulfur, Toxaphene
TDE, Zineb
TDE, Ziram
Toxaphene, Zineb

B. Sprays

BHC (Gamma), Captan
BHC (Gamma), Captan, Chlordane, DDT, Dinocap, Malathion, Sulfur
BHC (Gamma), Captan, Dinocap, Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
BHC (Gamma), Chloronaphthalenes, Hydroxyquinoline Sulfate
Captan, Carbaryl, Dicofol
Captan, Carbaryl, Dicofol, Dinocap
Captan, DDT, Ferbam, Malathion, Sulfur
Captan, DDT, Malathion
Captan, Diazinon, Methoxychlor, Zineb
Captan, Dicofol, Malathion, Methoxychlor
Captan, Dinocap, Lindane, Rotenoids, Rotenone, Piperonyl, Butoxide
Captan, 2-4,-Dinotro 6-(2-Cotyl) Phenyl Crotonate, Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
Captan, Dipropylene Glycol, Hexachlorophene, Dichlorophene, Lindane, Pyrethrins, Piperonyl Butoxide
Captan, Malathion, Methoxychlor
Captan, Malathion, Methoxychlor, Sulfur
Captan, Malathion, Methoxychlor, Zineb
Captan, Parathion
Carbaryl, Dicofol, Lindane, Zineb
Carbaryl, Folpet, Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
Carbaryl, Sulfur

II. Fungicide-Insecticide (Concluded)

B. Sprays (Concluded)

Carbaryl, Zineb
Chlordane, Piperonyl Butoxide, Pyrethrins
Copper, DDT
Copper, (Unspecified), DDT
Copper 8-Quinolinolate, Crotonate
Copper, Sulfate, (Basic), DDT
DDT, Ferbam
DDT, Lead Arsenate, Sulphur, Zinc Sulfate
Diazinon, Folpet
Dichlone, Dinocap, Methoxychlor, Pyrethrins, Rotenone
Dichlone, Sulfur
4,4'-Dichloro-Alpha-Trichloromethylbenzhydrol, Malathion, Methoxychlor, Tributyltin Compound
Ferbam, Malathion, Methoxychlor, Phenothiazine, Sulfur
Ferbam, Methoxychlor, TDE
Guthion, Parathion, Zineb
Heptachlor, Captan
Heptachlor, Pentachloronitrobenzene
Lead Arsenate, Sulfur, Zinc
Malathion, Metoxychlor, Sulfur
Parathion, Sulfur
Parathion, Sulfur, Zinc
Parathion, Zineb
Rotenone, Sulfur

III. Herbicides

Atrazine, Prometone
Atrazine, Sodium Chlorate, Sodium Metaborate
(2-Azido-4-Isopropylamino)-6-Methyl-Thio-s-Triazine
Bromacil, 2,4-D Ester, Oil, Pentachlorophenol
Bromacil, Sodium Chlorate, Sodium Metaborate
Cacodylate, Sodium, Dimethyl Arsenic Acid
Carbaryl, Diphenamid, Neburon
CDAA, TCBC
2,4-D, 2,4,5-T Amine Salts
2,4-D, 2,4,5-T Esters, Promotone
Dinitro-o-sec-Butylphenol, Triethanolamine Salt

I. Herbicides (Concluded)

Diosodium Tetraborate, Decahydrate or Pentahydrate, Trichlorobenzoic Acid
Diuron, Sodium Chlorate, Sodium Metaborate
Diuron, Sodium Metaborate Tetrahydrate, Sodium Chlorate
Fenuron, TCA
Linuron, 2-Chloro-N-Isopropylacetanilide
Monuron, Sodium Chlorate, Sodium Metaborate
Monuron-TCA
Pentachlorophenol, Triazine
Phenylmercuric Acetate, Thiram
Potassium Cyanate, Sodium Arsenite
Sodium Arsenite, Sodium Cresylate
Sodium Chlorate, Sodium Metaborate
Sodium Chlorate, Sodium Metaborate Tetrahydrate

IV. Insecticides

A. Aerosols

Allethrin, *n*-Octyl Benzylheptene, Dicarboximide, DDT, Methoxychlor, Oil, Organic Thiocyanates
Allethrin, *n*-Octyl Bicycloheptene Dicarboximide, DDT, Isobornyl Thiocyanoacetate, Methoxychlor, Oil
Allethrin, *n*-Octyl Bicycloheptene Dicarboximide, DDT, Oil, Organic Thiocyanates
Allethrin, DDT, Methoxychlor, Oil, Piperonyl Butoxide
Allethrin, Oil, Sulfoxide
Allethrin, Octyl Sulfoxide of Isosafrol, Oil, Pyrethrins
Allethrins, Pyrethrum
BHC (Gamma), Pine Oil
BHC (Gamma), Oil, Pine Oil, Piperonyl Butoxide, Pyrethrins
N-Octyl Bicycloheptene Dicarboximide, 2,3,4,5-Bis(2-Butylene)-Tetrahydro 2-Furaldehyde, Piperonyl Butoxide, Pyrethrin
Butoxypolypropylene Glycol, Oil, Piperonyl Butoxide, Pyrethrins
Carbaryl, Malathion, Methoxychlor, Methylenebis, Piperonyl Butoxide, Pyrethrins, Tetrahydrofurfural
Chlordane, *N*-Octyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins, Ronnel
Chlordane, Piperonyl Butoxide, Pyrethrins
Chloraniline Oleate, Chloraniline Salicylate
DDT, Dichlone, Methoxychlor, MGK, Pyrethrins, Rotenoids, Rotenone

IV. Insecticides (Continued)

A. Aerosols (Concluded)

DDT, Isobornyl Thiocyanoacetate, Oil
DDT, Piperonyl Butoxide, Pyrethrins
DDVP, Dichlorovos
DDVP, Dieldrin
DDVP, Dieldrin, Oil
DDVP, Oil, Pyrethrins
DDVP, Piperonyl Butoxide, Pyrethrins
DDVP, Pyrethrins
Diazinon, Oil, Piperonyl Butoxide, Pyrethrins
Diazinon, *n*-Ethylhexyl Bicycloheptene, Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
Dichlorophene, 1-Napthyl *n*-Methylcarbamate, Piperonyl Butoxide, Pyrethrins
Dichlorvos, Dieldrin, Oil, Piperonyl Butoxide, Pyrethrins
Dichlorovos, Ronnel
Dieldrin, Malathion
Dieldrin, Malathion, Oil
Di-N-Propyl Isocinchomeronate, Piperonyl Butoxide, Pyrethins
Ethylhexyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
Hydroxy Ethyl-*n*-Octyl Sulfide, Methoxychlor, Oil, Piperonyl Butoxide, Pyrethrins
Methylene Chloride, Oil, Piperonyl Butoxide, Pyrethrins
Methoxychlor, MGK, Oil, Piperonyl Butoxide, Pyrethrins
Methoxychlor, Organic Thiocyanates
Methoxychlor, Piperonyl Butoxide, Pyrethrins
Methoxychlor, Piperonyl Butoxide, Pyrethrins, Rotenone
Methoxychlor, Sulfur, TDE, Zineb
MGK-264, Oil, Piperonyl Butoxide, Pyrethrins
Oil, Piperonyl Butoxide, Pyrethrins
Piperonyl Butoxide, Pyrethrins
Piperonyl Butoxide, Pyrethrins, Oil
Piperonyl Butoxide, Pyrethrins, Rotenone
Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
Pyrethrins, Piperonyl Butoxide
Pyrethrins, Sulfoxide
Pyrethrum, Rotenone

IV. Insecticides (Continued)

B. Baits

Aldrin, Dieldrin
Calcium Arsenate, Metaldehyde
Carbaryl, Metaldehyde
Chlordane, Metaldehyde
DDVP, Malathion, Ronnel
DDVP, Ronnel
DDVP, Trichlorofon
Diazinon, Malathion
Malathion, Ronnel

C. Concentrates for Manufacturing

Butoxy Polypropylene Glycol, Pyrethrins, Sulfoxide
Diazinon, Pyrethrins, Sulfoxide
Ethylhexyl, Bicyclo 2,2,1;5-Heptene-2,3-Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
Malathion, Piperonyl Butoxide, Pyrethrins
MGK 264, Piperonyl Butoxide, Pyrethrins
Oil, Piperonyl Butoxide, Pyrethrins
Oil, Pyrethrins
Piperonyl Butoxide, Pyrethrins
Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
n-Propyl Isome, Pyrethrins
Pyrethrins, Oil
Pyrethrins, Sulfoxide

D. Dusts

BHC, Chlordane
BHC, DDT
BHC, DDT, Methyl Parathion
BHC, DDT, Parathion
BHC (Gamma), DDT
BHC (Gamma), DDT, Parathion
Borax, Chlordane, Oil, Paradichlorobenzene
Borax, Oil, Organic Thiocyanates, Paradichlorobenzene
Borax, Pyrethrins, Sodium Fluoride
Boric Acid (Butyl Carbityl) (6-Propyl Piperonyl) Ether, Hexachlorophene, Piperonyl Butoxide, Propylene Glycol, Pyrethrins
Butoxypolypropylene Glycol, Methoxychlor, MGK
Butoxypolypropylene Glycol, Piperonyl Butoxide, Pyrethrins

IV. Insecticides (Continued)

D. Dusts (Continued)

Carbaryl, Chlordane
Carbaryl, Chloranil
Carbaryl, Diphenamid, Fertilizer
Carbaryl, Malathion
Carbaryl, Methyl Parathion
Carbaryl, Naled
Carbaryl, Piperonyl Butoxide, Pyrethrins
Carbaryl, Parathion
Chlordane, Diazinon
Chlordane, Piperonyl Butoxide, Pyrethrins
Chlordane, Pyrethrins
Copper Sulfate, TDE
DDT, Endosulfan
DDT, Parathion, TDE
DDT, Lindane
DDT, O,O-Dimethyl S-(p-Chlorophenylthio) Methyl Phosphorodithioate
DDT, Methyl Parathion
DDT, Parathion
DDT, Parathion, Toxaphene
DDT, Toxaphene
Diazinon, Piperonyl Butoxide, Pyrethrins
Diazinon, Pyrethrins
Dicofol, Malathion
Endosulfan, Naled
Endosulfan, Parathion
Malathion, Piperonyl Butoxide, Pyrethrins
Methoxychlor, Oil, Piperonyl Butoxide, Pyrethrins
Methoxychlor, Piperonyl Butoxide, Pyrethrins
Naled, Sodium Fluoaluminate
Naled, Tetradifon
Oil, Piperonyl Butoxide, Pyrethrins
Organic Thiocyanates, TDE
Parathion, Sulfur
Parathion, TDE
Parathion, Toxaphene
Piperonyl Butoxide, Pyrethrins, Rotenoids, Rotenone
Piperonyl Butoxide, Pyrethrins, Silica Gel
Pyrethrum, Rotenone, Sodium Fluoride
Pyrethrins, Ryania Powder, Sodium Fluoride, Sodium Silicofluoride
Pyrethrum, Sodium Fluoride

. Insecticides (Continued)

D. Dusts (Concluded)

Rotenoids, Rotenone
Sabadilla, Alkaloids
TDE, Parathion
Toxaphene

E. Fumigants

Benzene, Carbon Tetrachloride, Ethylene Dibromide, Sulfur Dioxide
Bromopropyne, Chloropicrin, Methyl Bromide
Carbon Disulphide, Carbon Tetrachloride
Carbon Disulfide, Carbon Tetrachloride, Ethylene Dibromide
Carbon Disulfide, Carbon Tetrachloride, Ethylene Dibromide, Ethylene Dichloride
Carbon Disulfide, Carbon Tetrachloride, n-Pentane
Carbon Disulfide, Carbon Tetrachloride, Pentane, Sulfur Dioxide
Carbon Tetrachloride, Ethylene Dichloride
Carbon Tetrachloride, Ethylene Dibromide, Ethylene Dichloride
Carbon Tetrachloride, Ethylene Dibromide, Ethylene Dichloride, Sulfur Dioxide
Carbon Tetrachloride, Malathion, Oil, Piperonyl Butoxide, Pyrethrins
Chlorinated C_3 Hydrocarbons, Chloropicrin, Methyl Isothiocyanate
Chlorinated (3-Hydrocarbons), Methyl Isothiocyanate
DDVP, Piperonyl Butoxide, Pyrethrins, Tetrachloroethylene
Ethylene Dichloride, Propylene Dichloride
Formaldehyde, Furfuraldehyde
Methyl Bromide, Chloropicrin
Naphthalene, Sulfur
Piperonyl Butoxide, Pyrethrins, Tetrachloroethylene, Trichloroethylene

F. Granular

Aldrin, Parathion
BHC, (Gamma), DDT
Malathion, Methoxychlor

IV. Insecticides (Continued)

G. Insect Repellents

Benzene, Diphenylamine
Benzene, Pine Oil, Pine Tar
O,O,O',O'-Tetramethyl-O,O'-Thiodi-p-phenylene Phosphorthioate
BHC, Lindane, Pine Oil
Butoxypolypropylene Glycol, Chloroform, Pine Oil, Ronnel
Di-N-Butyl-Succinate, Piperonyl Butoxide, Pyrethrins
Deet (N,N, Diethyl-Meta-Toluamide), Diethyl Toluamide
Deet, Di-N-Propyl Isocinchomerate, 2,3,4-Bis-Delta - 2-Butylene Tetraphydrofurfuryl, n-Octyl Bicycloheptene Dicarboximide
Dicarboximide, Deet
Dimethyl Phthalate, 2-Ethyl Hexanediol, Indalone
Hydroxy-n-Octyl Sulfide, n-Octyl Bicycloheptene Dicarboximide, Oil

H. Mothproofing Materials

Dichloro-2,2-Bis (p-Ethylphenyl) Ethane, Oil
DDT, Oil, Piperonyl Butoxide
Dieldrin, Phenyl Mercuric Lactate
Maganese Silicofluoride, Thiocarbamide-Thiourea, Zinc
Oil, Terpene Polychlorinates, Chlorine
Paradichlorobenzene
Thiourea, Zinc Silicofluoride

I. Sprays

Alcohol, Glycols, Piperonyl Butoxide, Pyrethrins
Allethrin, Malathion, Methylene Chloride, N-Octyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Trichloroethylene
Allethrin, N-Octyl Bicycloheptenedicarboximide, Pyrethrins
Allethrin, n-Octyl Bicycloheptene Dicarboximide, Organic Thiocyanate, Methoxychlor, Oil
Allethrin, N-Propyl Isome
Allethrins, Pyrethrins
Aprocarb, Oil
BHC, Chlordane, DDT
BHC, Chlordane, Oil
BHC, DDT, Lindane
BHC, Toxaphene

IV. Insecticides (Continued)

I. Sprays (Continued)

BHC (Gamma), DDT, Genite, Malathion
BHC (Gamma), DDT, Pyrethrins
BHC (Gamma), Diazinon
BHC (Gamma), Diazinon, Malathion, Oil, Piperonyl Butoxide, Pyrethrins, Trepene Polychlorinates
BHC (Gamma), Kelthane
BHC (Gamma), Malathion, Ovicide
BHC (Gamma), Malathion, TDE
BHC (Gamma), Methoxychlor
BHC (Gamma), Methoxychlor, Oil
BHC (Gamma), Methyl Ethyl Ketone, Methylated Naphthalenes, Oil,
BHC (Gamma), Methylated Naphthalenes, Oil, Organic Thiocyanates,
BHC (Gamma), Oil
BHC (Gamma), Oil, Organic Thiocyanates
BHC (Gamma), Oil, Piperonyl Butoxide, Pyrethrins
BHC (Gamma), Oil, Toxaphene
BHC (Gamma), Pyrethrum
BHC (Gamma), Thiocyano Diethyl Ether, Malathion
BHC (Gamma), Thiocyano Diethyl Ether, Chlorophenyl Ethanol
BHC (Gamma), Toxaphene
N-Octyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
Borax, Isopropanol
beta-Butoxy-beta-Thiocyano Diethyl Ether, DDT.
beta-Butoxy-beta-Thiocyano Diethyl Ether, Pyrethrins, Rotenoids, Rotenone
Butoxypolypropene Glycol, Ethylene Glycol, Ether of Pinene, Piperonyl Butoxide, Pyrethrins, Rotenone
Butoxypolypropylene Glycol, Isobornyl Thiocyano Acetate, Methoxychlor
Butoxypolypropylene Glycol, Methoxychlor
Butoxypolypropylene Glycol, Methoxychlor, Oil, Piperonyl Butoxide, Pyrethrins
Butoxypolypropylene Glycol, Oil, Piperonyl Butoxide, Pyrethrins
Butoxypolypropylene Glycol, Piperonyl Butoxide, Pyrethrins
Carbaryl, Chlordane
Carbaryl, Malathion, 1,1-Bis(p-Chlorophenyl) Trichloroethanol
Carbaryl, Dicofol, Lindane, Malathion
Carbaryl, Lindane, Maneb
Carbaryl, Methyl Parathion
Carbaryl, Pyrethrins

IV. Insecticides (Continued)

I. Sprays (Continued)

Carbophenothion, DDT
Carbophenothion, Oil
Carboximide, Oil, Piperonyl Butoxide, Pyrethrins
Chlordane, DDT, Lindane
Chlordane, DDT, Malathion, Organic Thiocyanate
Chlordane, DDT, Methylated Naphthalenes, Oil
Chlordane, DDT, Oil
Chlordane, DDVP, Isobornyl Thiocyanoacetate, Oil
Chlordane, Diazinon, Oil, Piperonyl Butoxide, Pyrethrins
Chlordane, Dieldrin
Chlordane, Di-N-Propyl Maleate Isosafrole Condensate, Oil
Chlordane, Ethylene, Dibromide
Chlordane, Heptachlor
Chlordane, Malathion
Chlordane, Malathion, Oil
Chlordane, Malathion, Oil, Organic Thiocyanates
Chlordane, Oil, n-Octyl Bicycloheptene Dicarboximide, Piperonyl Butoxide, Pyrethrins
Chlordane, Oil
Chlordane, Oil, Organic Thiocyanates
Chlordane, Oil, Pentachlorophenol
Chlordane, Oil, Piperonyl Butoxide, Pyrethrins
Chlordane, Piperonyl Butoxide, Pyrethrins
Chlordane, Pyrethrins
1,1-Bis(P-Chlorophenyl) 2,2,2-Trichloro-ethanol, Meta Systox, Methoxychlor, Oil
1,1-Bis(p-Chlorophenyl) 2,2,2-Trichloroethanol, Toxaphene, Oil
Ciodrin, DDVP
Ciodrin, DDVP, Pyrethrins
Ciodrin, Vapona
Coal Tar Neutral Oils, Phenols, Soap
Cresylic Acid, DDT, Oil
2,4-Cyclopentadien-1-Bis-Pentachloro, Pentac
DDT, Dieldrin
DDT, O,O-Dimethyl S-(p-Chlorophenylthio)methyl Phosphorodithioate
DDT, Endosulfan
DDT, Endrin
DDT, Endrin, Methyl Parathion
DDT, Guthion
DDT, Heptachlor, Methyl Parathion

Insecticides (Continued)

I. Sprays (Continued)

DDT, Malathion
DDT, Methyl Naphthalenes
DDT, Methyl Parathion
DDT, Methyl Parathion, Terpene Polychlorinates
DDT, Methyl Parathion, Toxaphene
DDT, Methylated Naphthalenes, Organic Thiocyanates, Oil
DDT, Methylated Naphthalenes, Oil, Xylol
DDT, Oil
DDT, Organic Thiocyanates, Oils
DDT, Oil, Toxaphene
DDT, Organic Thiocyanates
DDT, Ovex
DDT, Parathion
DDT, Parathion, TDE
DDT, Parathion, Toxaphene
DDT, Phosphamidon
DDT, Rotenone, Sulfur, Ziram
DDT, Terpene Polychlorinates
DDT, TDE
DDT, Toxaphene
DDT, Xylene
DDT, Zineb
DDVP, Ciodrin
DDVP, Cygon, Oil
DDVP, Dieldrin, Oil
DDVP, Diazinon
DDVP, 1,1-Dichloro-2,2-Bis(p-Ethylphenyl)ethane
DDVP, Dieldrin
DDVP, Dimethyl Phosphate
DDVP, Di-N-Propyl Isocinchomerate, Hexahydro Dibenzofuran-Carboxaldehyde, Organic Thiocyanates, Pyrethrum
DDVP, Dipterex
DDVP, Dursban
DDVP, N-Ethylhexyl, Bicycloheptene Dicarboximide, Piperonyl Butoxide, Pyrethrins
DDVP, Isopropoxyphenyl Methylcarbamate, Oil
DDVP, Lindane, Oil
DDVP, alpha-Methylbenzyl-3-(Dimethoxyphosphinyloxy)-cis_ Crotonate
DDVP, Oil
DDVP, Oil, Ronnel
DDVP, Oil, Piperonyl Butoxide

IV. Insecticides (Continued)

I. Sprays (Continued)

DDVP, Piperonyl Butoxide, Pyrethrins
Demeton, Dicofol, Methoxychlor
Diazinon, n-Octyl Bicycloheptene Dicarboximide, Oil, Pyrethrins
Diazinon, N-Octyl Bicycloheptene Dicarboximide, Piperonyl Butoxide, Pyrethrins
Diazinon, Dichlorovos
Diazinon, Dicofol
Diazinon, N-Ethylhexyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
Diazinon, Lindane, Malathion, Piperonyl Butoxide, Pyrethrins, Terpene Polychlorinates
Diazinon, Methoxychlor
Diazinon, Lindane, Oil, Piperonyl Butoxide, Pyrethrins
Diazinon, Dieldrin, Piperonyl Butoxide, Pyrethrins
Diazinon, Oil
Diazinon, Oil, Dichlorobenzene, Piperonyl Butoxide, Pyrethrins
Diazinon, Oil, Organic Thiocyanates
Diazinon, Piperonyl Butoxide, Pyrethrins
Diazinon, Pyrethrins
Diazinon, Pyrethrum
Diazinon, TDE
Di-N-Butyl Succinate, Oil, Piperonyl Butoxide, Pyrethrins
Di-N-Butyl Succinate, Pyrethrins
Dicapthon, Oil
Dichlorobenzene, Oil
Dichlorobenzene, Terpene Polychlorinates
1,1-Dichloro-2,2-Bis(p-Ethylphenyl)ethane, P-Dioxaneditiol-Bis-(0,0-Diethylphosphorodithioate)Dodecylbenzenesulfonate, Oil, Pine Oil
1,1-Dichloro-2,2-Bis(p-Ethylphenyl)ethane, Octyl Sulfoxide of Isosafrole, Pyrethrins
1,1-Dichloro-2,2-Bis(Ethane, Piperonyl Butoxide, Pyrethrins
Dichloromethyl-4,4'-Dichlorobenzhydrol, Malathion, Methoxychlor, Oil
Dichloro, Trichloromethylbenzhydrol, Oil
Dicofol, Oil, Trichloroethanol
Dicofol, Pyrethrins, TDE
Dicofol, Toxaphene
Dieldrin, Oil
Dieldrin, Pyrethrins, Sulfoxide
Dieldrin, TDE

IV. Insecticides (Continued)

I. Sprays (Continued)

O,O-Dimethyl O-[4-(methylthio)-*m*-Tolyl]phosphorathioate, Piperonyl Butoxide, Pyrethrins, Oil
Endosulfan, Methyl Parathion
Endosulfan, Oil
Endosulfan, Parathion
Endrin, Methyl Parathion
Endrin, Oil
Ethion, Oil
N-2-Ethylhexyl Bicyclo 2,2,1-5-Heptene-2,3-Dicarboximide, Methoxychlor, Piperonyl Butoxide, Pyrethrins
N-Ethylhexyl Bicycloheptene Dicarboximide, Oil, Piperonyl Butoxide, Pyrethrins
N-2-Ethylhexyl Bicyclo 2,2,1-5-Heptene,2,3-Dicarboximide, Piperonyl Butoxide, Pyrethrins
N-2-Ethylhexyl Bicyclo 2,2,1-5-Heptene-2,3-Dicarboximide, Pyrethrins
Heptachlor, Oil
Hexahydro Dibenzofurancarboxaldehyde, Organic Thiocyanates, Piperonyl Butoxide, Pyrethrins
(*o*-Isopropoxyphenyl Methyl Carbamate), Oil
Isopropoxyphenyl Methyl Carbamate, Piperonyl Butoxide, Pyrethrins
Kelthane, Metasystox, Methoxychlor
Kelthane, Toxaphene
Lethane, Malathion, Oil
Malathion, Methoxychlor
Malathion, Methylated Naphthalenes
Malathion, Methylene Chloride, Oil, Piperonyl Butoxide, Pyrethrins
Malathion, Oil
Malathion, Oil, Organic Thiocyanates
Malathion, Oil, Toxaphene
Malathion, Piperonyl Butoxide, Pyrethrins
Malathion, Pyrethrins, Rotenoids, Rotenone
Malathion, TDE
Malathion, Toxaphene
Malathion, Xylene
Meta-Systox, Methoxychlor, Dicofol
Meta-Systox, Oil
Methoxychlor, Oil
Methoxychlor, Oil, Organic Thiocyanates
Methoxychlor, Oil, Piperonyl Butoxide, Pyrethrins

IV. Insecticides (Concluded)

I. Spray (Concluded)

Methoxychlor, Piperonyl Butoxide, Pyrethrins
Methoxychlor, Toxaphene
Methyl Naphthalenes, Oil, Pentachlorophenol
Methyl Parathion, Ethyl Paration
Methyl Parathion, Oil, Toxaphene
Naled, Oil
Nicotine, Oil
Oil, Organic Thiocyanates
Oil, Organic Thiocyanates, Piperonyl Butoxide, Pyrethrins
Oil, Piperonyl Butoxide, Pyrethrins
Oil, Piperonyl Butoxide, Pyrethrins, TDE
Oil, Pyrethrins
Oil, Pyrethrins, Rotenoids, Rotenone
Oil, Pyrethrins, Sulfoxide
Oil, Rotenone
Oil, Tetradifon
Oil, Toxaphene
Parathion, TDE
Petroleum Hydrocarbon, Piperonyl Butoxide, Pyrethrins
Pine Oil, Pyrethrins, Rotenone
Piperonyl Butoxide, Pyrethrins
Piperonyl Butoxide, Pyrethrins, Tetrachloroethylene
Piperonyl Butoxide, Pyrethrins, Toxaphene
Polyvinylpyrrolidine, Iodine
Pyrethrins, Rotenone
Pyrethrins, Rotenone, Ryania
Pyrethrins, Sulfoxide
Pyrethrum, Piperonyl Butoxide
Pyrethrum, Rotenone
Silica Gel, Oil, Piperonyl Butoxide, Pyrethrins

V. Rodenticides

Sodium Fluosilicate, Zinc Cyanide
Sulfoquinoxalin Warfarin

VI. Seed Treatment

Aldrin, Captan, Tar Oil
Aldrin, Hardwood Oils
Aldrin, Hexachlorobenzene
Aldrin, Thiram
Aldrin, Xylol
BHC (Gamma), Captan, Diazinon
BHC (Gamma), Maneb
Brominated Salicylanilides
Captan, Diazinon
Captan, Dieldrin
Captan, Hexachlorobenzene
Captan, Malathion
Captan, Methoxychlor
Captan, Pentachloronitrobenzene
Captan, Streptomycin
Copper Carbonate
Dieldrin, Pentachlorophenol
Dieldrin, Thiram
Hexachlorobenzene, Maneb
Mercury, Cadmium Dilactate
Methoxychlor Technical, Thiram
Methyl Mercury Acetate, Methyl Mercury 2,3-Dihydroxy Propyl Mercaptide
Molybdenum, Thiram
Streptomycin, Zineb

VII. Wood Preservatives

Aldrin,(Tributyltin) Oxide
Captan, Lindane
Chlordane, Oil, Pentachlorophenol
Coal Tar, Coal Tar Acids, Raw Coal Tar
Copper Naphthenate, Oil
Dinitrophenol, Disodium Hydrogen Arsenate, Sodium Chromate, Sodium Fluoride
Oil, Anthracene
Oil, Asphaltic
Oil, Pentachlorophenol
Oil, Pentachlorophenol, Tetrachlorophenol
Pentachlorophenol, Other Chlorophenols

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PART B: METHODS FOR THE DISPOSAL OF UNUSED OR SPILLED PESTICIDES

SECTION IX

HOW TO USE THE MANUAL

This manual is intended to aid responsible and knowledgeable persons (e.g., Regional EPA officials, county agents, Public Health Service representatives, etc., hereinafter referred to as "the authority" in this manual) in solving the pesticide disposal, spill, or container problems of the layman. It contains information that, taken in conjunction with the general information of Part I and a knowledge of local regulations and conditions, can be used to select a method for the disposal of any one of 550 pesticide chemicals. Fourteen general pesticide-disposal procedures which can be tailored to suit each specific disposal problem and local conditions are described. Procedures for the disposal of containers and for the cleanup of spills are also given.

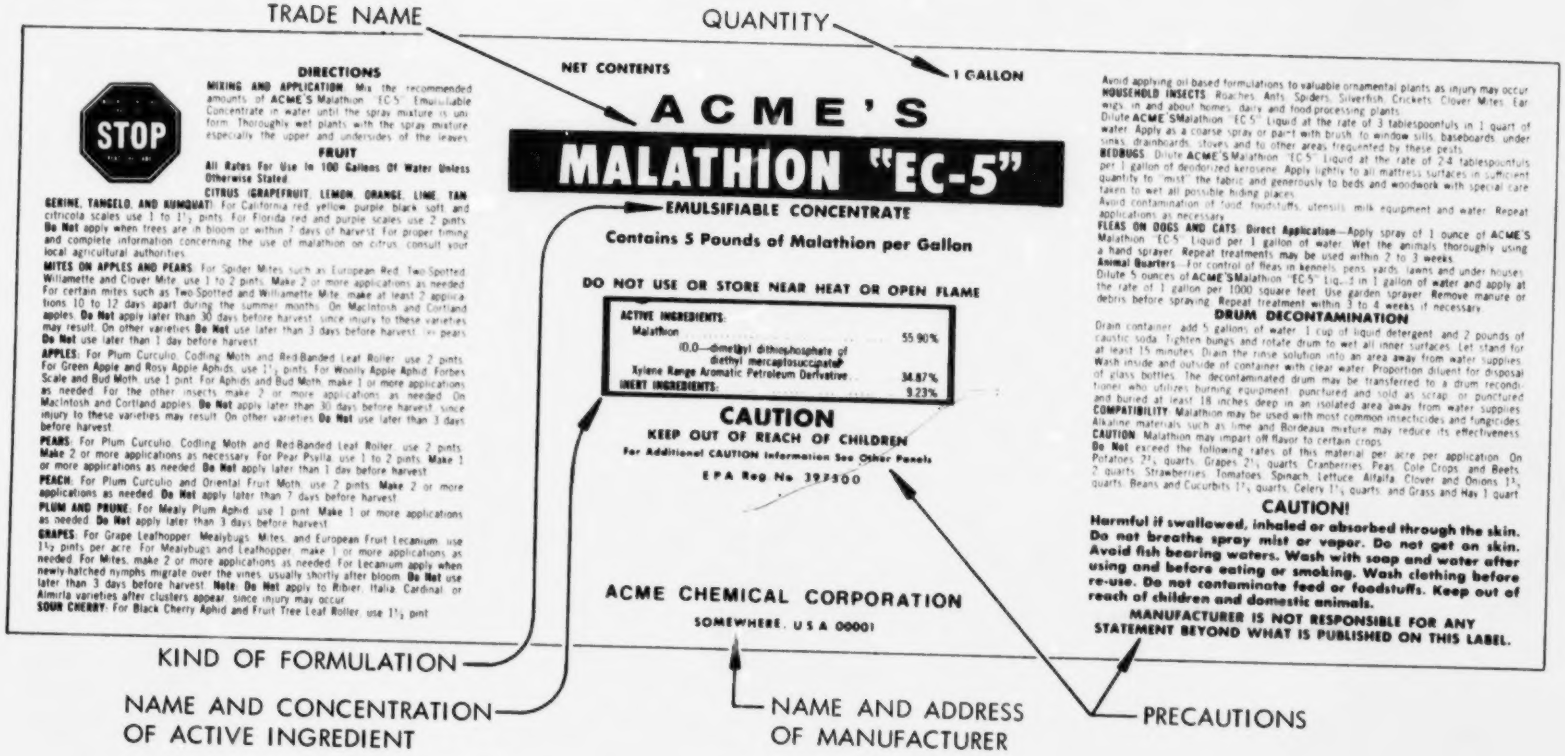
The proper disposal of pesticides or of pesticide containers requires careful consideration of many factors as discussed in Sections V and VI of Part I. The user of this manual should follow the following six steps:

STEP 1 - Read the Label: When the layman calls the authority or brings in his pesticide, the authority must first determine what the label on the package says. A sample label and the location of pertinent information on it are shown in Figure 4. In particular, he must determine: (a) The approximate quantity of pesticide to be disposed of, i.e., a 5-gal. can or a 50-lb bag; (b) the name and concentration of the pesticide--the common or chemical names and percent concentrations that are listed under "active ingredients"--as well as the trade name, which is usually in larger letters; (c) the kind of formulation, e.g., emulsifiable concentrate, dust, etc., which is involved; (d) the precautions for handling and use that the manufacturer specifies (the authority should make sure that if the layman has an unusually hazardous material, he is aware of this fact); (e) the name and address of the pesticide manufacturer.

The authority must determine whether the problem pesticide has only one active ingredient or is a mixture of two or more active ingredients. If the pesticide contains only one active ingredient, the authority can follow Steps 2 through 4. If it is a mixture, the selection of a disposal method as well as the disposal procedure itself may be more difficult, as will be discussed in Step 5.

If the layman's problem in either case involves container disposal or a spill cleanup, Step 6 should also be used.

STEP 2 - Determine the Primary Name: A single pesticide chemical may have one or more widely used trade names, one of more common names, and one or


TRADE NAME
QUANTITY
KIND OF FORMULATION
NAME AND CONCENTRATION OF ACTIVE INGREDIENT
NAME AND ADDRESS OF MANUFACTURER
PRECAUTIONS
STOP

DIRECTIONS

MIXING AND APPLICATION: Mix the recommended amounts of **ACME'S** Malathion "EC-5" Emulsifiable Concentrate in water until the spray mixture is uniform. Thoroughly wet plants with the spray mixture especially the upper and undersides of the leaves.

FRUIT

All Rates For Use In 100 Gallons Of Water Unless Otherwise Stated

CITRUS (GRAPEFRUIT, LEMON, ORANGE, LIME, TANGERINE, TANGELO, AND KUMQUAT): For California red, yellow, purple, black, soft and citricola scales use 1 to 1½ pints. For Florida red and purple scales use 2 pints. **Do Not** apply when trees are in bloom or within 7 days of harvest. For proper timing and complete information concerning the use of malathion on citrus, consult your local agricultural authorities.

MITES ON APPLES AND PEARS: For Spider Mites such as European Red, Two-Spotted, Willamette and Clover Mite, use 1 to 2 pints. **Make** 2 or more applications as needed. For certain mites such as Two-Spotted and Williamette Mite, make at least 2 applications 10 to 12 days apart during the summer months. On Macintosh and Cortland apples, **Do Not** apply later than 30 days before harvest, since injury to these varieties may result. On other varieties **Do Not** use later than 3 days before harvest. On pears **Do Not** use later than 1 day before harvest.

APPLES: For Plum Curculio, Codling Moth and Red-Banded Leaf Roller, use 2 pints. For Green Apple and Rosy Apple Aphids, use 1½ pints. For Woolly Apple Aphid, Forbes Scale and Bud Moth, use 1 pint. For Aphids and Bud Moth, make 1 or more applications as needed. For the other insects make 2 or more applications as needed. On Macintosh and Cortland apples, **Do Not** apply later than 30 days before harvest, since injury to these varieties may result. On other varieties **Do Not** use later than 3 days before harvest.

PEARS: For Plum Curculio, Codling Moth and Red-Banded Leaf Roller, use 2 pints. **Make** 2 or more applications as necessary. For Pear Psylla, use 1 to 2 pints. **Make** 1 or more applications as needed. **Do Not** apply later than 1 day before harvest.

PEACH: For Plum Curculio and Oriental Fruit Moth, use 2 pints. **Make** 2 or more applications as needed. **Do Not** apply later than 7 days before harvest.

PLUM AND PRUNE: For Mealy Plum Aphid, use 1 pint. **Make** 1 or more applications as needed. **Do Not** apply later than 3 days before harvest.

GRAPES: For Grape Leafhopper, Mealybugs, Mites, and European Fruit Lecanium, use 1½ pints per acre. For Mealybugs and Leafhopper, make 1 or more applications as needed. For Mites, make 2 or more applications as needed. For Lecanium apply when newly-hatched nymphs migrate over the vines, usually shortly after bloom. **Do Not** use later than 3 days before harvest. **Note**: **Do Not** apply to Ribier, Italia, Cardinal, or Almirla varieties after clusters appear, since injury may occur.

SOUR CHERRY: For Black Cherry Aphid and Fruit Tree Leaf Roller, use 1½ pint

NET CONTENTS **1 GALLON**

ACME'S

MALATHION "EC-5"

EMULSIFIABLE CONCENTRATE

Contains 5 Pounds of Malathion per Gallon

DO NOT USE OR STORE NEAR HEAT OR OPEN FLAME

ACTIVE INGREDIENTS:	
Malathion	55.90%
(0,0—dimethyl dithiophosphate of diethyl mercaptosuccinate)	
Xylene Range Aromatic Petroleum Derivative	34.87%
INERT INGREDIENTS:	9.23%

CAUTION

KEEP OUT OF REACH OF CHILDREN

For Additional CAUTION Information See Other Panels

EPA Reg No 397500

ACME CHEMICAL CORPORATION

SOMEWHERE, U.S.A. 00001

Avoid applying oil-based formulations to valuable ornamental plants as injury may occur.

HOUSEHOLD INSECTS: Roaches, Ants, Spiders, Silverfish, Crickets, Clover Mites, Earwigs, in and about homes, dairy and food processing plants.

Dilute **ACME'S** Malathion "EC-5" Liquid at the rate of 3 tablespoonfuls in 1 quart of water. Apply as a coarse spray or paint with brush to window sills, baseboards, under sinks, drainboards, stoves and to other areas frequented by these pests.

BEDBUGS: Dilute **ACME'S** Malathion "EC-5" Liquid at the rate of 2-4 tablespoonfuls per 1 gallon of deodorized kerosene. Apply lightly to all mattress surfaces in sufficient quantity to "mist" the fabric and generously to beds and woodwork with special care taken to wet all possible hiding places.

Avoid contamination of food, foodstuffs, utensils, milk equipment and water. Repeat applications as necessary.

FLEAS ON DOGS AND CATS: **Direct Application**—Apply spray of 1 ounce of **ACME'S** Malathion "EC-5" Liquid per 1 gallon of water. Wet the animals thoroughly using a hand sprayer. Repeat treatments may be used within 2 to 3 weeks.

Animal Quarters—For control of fleas in kennels, pens, yards, lawns and under houses: Dilute 5 ounces of **ACME'S** Malathion "EC-5" Liquid in 1 gallon of water and apply at the rate of 1 gallon per 1000 square feet. Use garden sprayer. Remove manure or debris before spraying. Repeat treatment within 3 to 4 weeks if necessary.

DRUM DECONTAMINATION

Drain container, add 5 gallons of water, 1 cup of liquid detergent, and 2 pounds of caustic soda. Tighten bungs and rotate drum to wet all inner surfaces. Let stand for at least 15 minutes. Drain the rinse solution into an area away from water supplies. Wash inside and outside of container with clear water. Proportion diluent for disposal of glass bottles. The decontaminated drum may be transferred to a drum reconditioner who utilizes burning equipment, punctured and sold as scrap, or punctured and buried at least 18 inches deep in an isolated area away from water supplies.

COMPATIBILITY: Malathion may be used with most common insecticides and fungicides. Alkaline materials such as lime and Bordeaux mixture may reduce its effectiveness.

CAUTION: Malathion may impart off flavor to certain crops.

Do Not exceed the following rates of this material per acre per application. On Potatoes 2⅔ quarts, Grapes 2⅓ quarts, Cranberries, Peas, Cole Crops, and Beets 2 quarts, Strawberries, Tomatoes, Spinach, Lettuce, Alfalfa, Clover and Onions 1⅔ quarts, Beans and Cucurbits 1⅔ quarts, Celery 1⅓ quarts, and Grass and Hay 1 quart.

CAUTION!

Harmful if swallowed, inhaled or absorbed through the skin. Do not breathe spray mist or vapor. Do not get on skin. Avoid fish bearing waters. Wash with soap and water after using and before eating or smoking. Wash clothing before re-use. Do not contaminate feed or foodstuffs. Keep out of reach of children and domestic animals.

MANUFACTURER IS NOT RESPONSIBLE FOR ANY STATEMENT BEYOND WHAT IS PUBLISHED ON THIS LABEL.

more different chemical names. In this manual, a primary entry name has been selected for each of the 550 pesticide chemicals. The user must turn to the cross-index of names (p. 177) and determine the primary entry name for the pesticide chemical or chemicals. Over 1,700 names are entered alphabetically in this list including 550 primary entries and over 1,200 "secondary entries," (alternate trade, common or chemical names) which are keyed to the prime entries. For example, if one receives an inquiry about disposal of AAtrex®, the cross-index would show that pertinent information would be found under the common name, atrazine. Detailed directions for use of the cross-index are given on page 177.

STEP 3 - Find the Pesticide in the Chart of Properties: After the primary entry name for the pesticide has been determined, the manual user should find that name in the "Reference Charts of Pesticide Properties Pertinent to Disposal." Instructions for use of the charts are given on page 212. The table lists information on the uses and formulations of each pesticide as well as data on the physical, toxicological and environmental properties of each pesticide chemical. The table also lists the preferred and alternate disposal procedures that are described in Section XII. In addition, a reference is given to the page in Section VII on which literature information on the degradation chemistry of each compound is summarized. For example, if one looked under atrazine, the chart indicates that it is a herbicide formulated as a wettable powder and as granules and has certain physical, biological, and environmental properties. The chart also indicates that further information on the reaction chemistry of the triazine group of pesticides could be found in Section VII and that atrazine could be disposed of by a procedure described in Section XII.

STEP 4 - Select and Adapt the Disposal Procedure: Based on the manual's recommendations of preferred and alternate disposal procedures and a knowledge of local regulations and conditions, the responsible authority can select the appropriate Disposal Procedure. In addition, based on the amount and the composition of material involved, the authority can adapt the general procedure to the specific disposal problem as illustrated by examples in Section XII. The authority can, if he wishes, supply the layman with a copy of the selected disposal procedure to which he has added specific suggestions, e.g., he may suggest the specific chemical and the approximate amount to use to detoxify the layman's product. If the preferred disposal procedure is to turn the pesticide over to a collection agency, manufacturer, or disposal service, the authority can utilize the lists of agencies given in Procedures 1-3 and of manufacturers given in Appendices A and B.

STEP 5 - How to Handle a Mixture: The number of "mixed" pesticides on the market (i.e., products which contain two or more active ingredients) is very large, and the compositions of these mixtures are complex, as described in

Part I, p. 21 and in Appendix D. The relative proportions of ingredients may vary with the manufacturer and the intended application, and may be changed from time to time. Specific disposal procedures are not recommended herein for most of such mixtures. The responsible authority, when confronted by a disposal problem involving a mixture, should identify the nature and amount of each active ingredient, review the properties of each, determine what would be the best disposal method for each, and then determine the method which appears to be indicated or to be the best compromise for the mixture. This selection will have to be made on a case-by-case basis, and will require some common sense judgments on the part of the authority in determining the trade-offs between concentrations, toxicities, persistence and availabilities of suitable methods. Further guidelines for mixtures are discussed on p. 292.

STEP 6 - How to Handle Containers and Spills: When the layman has a problem involving the disposal of spilled pesticides or "empty" pesticide containers, the authority should select the appropriate instructions given in Potential Disposal Procedures Available to the Layman, Sec. XII. He should then apply Steps 1 through 5 above, as necessary, to supplement and adapt the procedure for the layman's problem, e.g., for the specific pesticide spilled.

SECTION X

CROSS-INDEX OF CHEMICAL, COMMON AND TRADE NAMES OF PESTICIDES

This section contains a cross-index of over 1,500 chemical, common and trade names for 550 pesticidal chemicals which are currently or have recently been commercially available in the United States. The index contains two types of entries: primary names and secondary names. There is one primary entry or name for each pesticide to which all other names refer. Primary entries are written entirely in capital letters, and are found in alphabetical order in the Reference Charts in Section VII. Secondary entries have only the first letter capitalized, except when a registered trademark is otherwise; and are followed by a reference to the primary entry name. The primary and secondary entries are arranged alphabetically in the cross-index.

The names designated as the primary entries were selected generally on the basis of the following priorities.

* Common names adopted by the American National Standards Institute, ANSI, or its predecessors.[2]

* Common names adopted by the Weed Science Society of America (WSSA).[5]

* Common names adopted by the International Organization for Standardization (ISO) and shown by Martin[8] as being accepted in the United States.

* Primary entry names used in the report in Chemical Week[1a] even though these names have no official standing. Common names assigned by the Entomological Society of America[6] are included in the Chemical Week list.

* Chemical names, where well-known common or trade names are unavailable. Names were checked against those on ingredient statements on labels by the USDA.[9] The USDA publication frequently utilizes Chemical Abstracts nomenclature. It uses many more chemical names as primary entries than does the present cross-index.

The alphabetical arrangement of pesticide names uses the following convention:

* Prefixes that indicate position or optical activity are not considered in alphabetizing. These prefixes include: numbers, such as the 3 and 4 in 3,4-Dichloropropionanilide; the lower case letters o, m, n, p, α, β; the upper case letters D, DL, N, O, S, and Z; and the prefixes cis, sec, tert, and trans.

* Prefixes that indicate composition are considered in alphabetizing: bis, di, meta, mono, ortho, para, penta, tetra, tri, etc.

* Names that consist of only numbers, such as 6-12 and 1080, are listed after the alphabetical listing.

Name	Refer To
AAtrex	ATRAZINE
2-AB	2-AMINOBUTANE
ABATE®	
Acaraben®	CHLOROBENZILIATE
ACARALATE®	
Accelerate	ENDOTHALL
ACEPHATE	
S-(2-ACETAMIDOETHYL) O,O-DIMETHYL PHOSPHORODITHIOATE	
S-(2-Acetamidoethyl)dimethyl phosphorothiolothionate	S-(2-ACETAMIDOETHYL)-O,O-DIMETHYL PHOSPHORODITHIOATE
ACETIC ACID	
3-(α-Acetonylbenzyl)-4-hydroxycoumarin	WARFARIN
3-(α-Acetonylfurfuryl)-4-hydroxycoumarin	FUMARIN
3-(2-Acetonylfurfuryl)-4-hydroxycoumarin	FUMARIN
2-Acetyl-5-hydroxy-3-oxo-4-hexenoic acid delta-lactone	DEHYDROACETIC ACID
3-Acetyl-6-Methyl-2,4-pyrandione	DEHYDROACETIC ACID
Acquinite®	CHLOROPICRIN
Acritet®	ACRYLONITRILE
ACROLEIN	
Acrylaldehyde	ACROLEIN
ACRYLONITRILE	
Actellic®	PIRIMIPHOS METHYL
Actidione®	CYCLOHEXIMIDE
Actril®	IOXYNIL
Aero	CALCIUM CYANAMIDE
Aero® cyanatweed killer	KOCN
Afalon	LINURON
Afesin®	MONOLINURON
AG500	DIAZINON
Agrimycin	STREPTOMYCIN

Name	Refer To
Agri-Strep	STREPTOMYCIN
Agritol®	*BACILLUS THURINGIENSIS*
Agrox®	PHENYLMERCURY UREA
Agroxone®	MCPA
AKTON®	
ALACHLOR	
Alanap®	NAPTALAM
Alar®-85	SUCCINIC ACID-DIMETHYLHYDRAZIDE
Alcohol C_8, C_{10}	n-OCTANOL and n-DECANOL
ALDICARB	
ALDRIN	
Alfa-tox®	DIAZINON®
Alfol-10	n-DEC[illegible]
Alkron	PARATHION®
3-Alkyl-6-carbethoxy-5-(3,4-methylenedioxyphenyl-2-cyclohexene-1-one	PIPERONYL CYCLONENE
3-Alkyl-5-(3,4-methylenedioxyphenyl)-2-cyclohexene-1-one	PIPERONYL CYCLONENE
Alleron®	PARATHION
ALLETHRIN	
Alltex®	TOXAPHENE
ALLYL ALCOHOL	
Allyl homolog of cinerin I	ALLETHRIN
DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with D-trans chrysanthemum monocarboxylic acid	ALLETHRIN
DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of *cis* and *trans* DL-chrysanthemum monocarboxylic acid	ALLETHRIN
ALODAN	
ALORAC	
Alticide®	SODIUM CHLORATE
ALUMINUM PHOSPHIDE	

Name	Refer To
AMETRYNE	
Amiben	CHLORAMBEN
AMIDITHION	
2-AMINOBUTANE	
2-Aminobutane carbonate	2-AMINOBUTANE
Aminocarb	MATACIL®
5-Amino-4-chloro-2-phenyl-3-(2H)-pyridizinone	PYRAZON
3-Amino-2,5-dichlorobenzoic acid	CHLORAMBEN
3-Amino-1,2,4-triazole	AMITROLE
4-Amino-3,5,6-trichloropicolinic acid	PICLORAM
AMITROLE	
Amizine®	SIMAZINE
Ammate®	AMS
Ammoniates of [ethylene-bis-(dithiocarbamate)] zinc and ethylenebis[dithiocarbamic] acid	POLYRAM®
Ammonium sulfamate	AMS
Amobam	ZINEB
Amiben	CHLORAMBEN
AMS	
3-sec-Amylphenyl-N-methylcarbamate	BUX TEN®
ANCYMIDOL	
Animert	p-CHLOROPHENYL-2,4,5-TRICHLOROPHENYLSULFIDE
Anofex®	DDT
Ansar 157	MAMA
Ansar® 170,529	MSMA
Ansar® 184	DSMA
Antak®	n-DECANOL
Anthon®	TRICHLORFON
ANTHRAQUINONE	
Anticarie®	HCB

Name	Refer To
ANTIMONY POTASSIUM TARTRATE	
ANTIRESISTANT/DDT	
ANTU®	
Aqualin®	ACROLEIN
Aquathol	ENDOTHALL
Aracide	ARAMITE®
ARAMITE®	
Arasan®	THIRAM
Arathane®	KARATHANE®
Aresin®	MONOLINURON
Aretit®	DINOSEB ACETATE
Arresin®	MONOLINURON
Arsan	CACODYLIC ACID
ARSENIC ACID	
ARSENIOUS OXIDE	
ASPON®	
ASULAM	
Asuntol®	COUMAPHOS
Atratol	ATRAZINE
ATRATRONE	
ATRAZINE	
Avadex®	DIALLATE
Avadex BW®	TRIALLATE
Azak®	TERBUTOL
AZINPHOSETHYL	
AZINPHOSMETHYL	
AZOBENZENE	
Azobenzide	AZOBENZENE
AZODRIN®	
Azofume	AZOBENZENE

Name	Refer To
BACILLUS THURINGIENSIS	
Bakthane®	BACILLUS THURINGIENSIS
Balan®	BENEFIN
BANDANE®	
Banol®	SOK®
Bantrol®	IOXYNIL
Banvel® D	DICAMBA
Banvel® T	TRICAMBA
BARBAN	
Baron®	ERBON
BARTHRIN	
Basic copper carbonate	COPPER CARBONATE, BASIC
Basic cupric chloride	COPPER OXYCHLORIDE SULFATE
Basudin®	DIAZINON
Batasan®	FENTIN ACETATE
Bay 30686	ERADEX®
Bay 39007	BAYGON®
Bayer 22555	DEXON®
Bayer 36205	MORESTAN®
Bayer 38819	GOPHACIDE®
Bayer 44646	METACIL®
BAYGON®	
BAYLUSCIDE®	
Baytex®	FENTHION
Belt®	CHLORDANE
BENEFIN	
Benlate	BENOMYL
BENOMYL	
BENSULIDE	
BENTAZON	
Benzabor®	2,3,6-TBA
BENZADOX	
Benzahex®	BHC

Name	Refer To
Benzamidooxy acetic acid	BENZADOX
BENZENE	
Benzene hexachloride	BHC, see also LINDANE
Benzex®	BHC
Benzofume	AZOBENZENE
Benzol	BENZENE
BENZOMATE	
2-Benzothiazolethiol	2-MERCAPTOBENZOTHIAZOLE
4-Benzothienyl-N-methyl-carbamate	MOBAM®
BENZYL BENZOATE	
(5-Benzyl-3-furyl) methyl-2,2-dimethyl-3-(2-methylpropenyl)-cyclopropane carboxylate	SBP-1382
BENZYL THIOCYANATE	
Betanal®	PHENMEDIPHAM
Betasan	BENSULIDE
Bexide	EXD
BHC	
BHC, γ-isomer	LINDANE
BIDRIN®	
BINAPACRYL	
Binnell	BENEFIN
Bioallethrin	D-TRANS ALLETHRIN®
Bioquin®	COPPER-8-QUINOLINOLATE; see also 8-QUINOLINOL
Biotrol BTB®	BACILLUS THURINGIENSIS
BIPHENYL	
BIS-1,4-BROMOACETOXY-2-BUTENE	
2,3,4,5-bis(2-Butylene)tetrahydro-2-furaldehyde	MGK REPELLENT 11®
1,3-bis(Carbamoylthio)-2-(N,N-dimethylamino)propane, hydrochloride	S,S'-[2-(DIMETHYLAMINO)TRIMETHYLENE]bis(THIOCARBAMATE), HYDROCHLORIDE
bis(2-Chloroethyl)ether	DICHLOROETHYL ETHER
O,O-bis(p-Chlorophenyl)-acetimidoylphosphoramidothioate	GOPHACIDE

Name	Refer To
1,1-bis(p-Chlorophenyl)-2-nitrobutane and 1,1-bis(p-chlorophenyl)-2-nitropropane	DILAN®
α,α-bis(p-Chlorophenyl)-3-pyridinemethanol	PARINOL
bis(Chlorophenyl)-2,2,2-trichloroethanol	DICOFOL
1,1-bis(p-Chlorophenyl)-2,2,2-trichloroethanol	DICOFOL
2,6-BIS(DIMETHYLAMINOMETHYL)-CYCLOHEXANONE	
bis(Dimethylthiocarbamoyl) disulfide	THIRAM
1,3-bis(1-Hydroxy-2,2,2-trichloroethyl) urea	DCU
2,4-bis(Isopropylamino)-6-methoxy-s-triazine	PROMETONE
2,4-bis(Isopropylamino)-6-(Methylthio-s-triazine	PROMETRYNE
2,2-bis(p-Methoxyphenyl)-1,1,1-trichloroethane	METHOXYCHLOR
2,4-bis[(3-Methoxypropyl)-amino]-6-methylthio-s-triazine	MPMT
N,N-bis(Phosphonomethyl)-glycine	GLYPHOSINE
BIS(TRI-n-BUTYLTIN)OXIDE	
1,3-bis(2,2,2-Trichloro-1-hydroxyethyl) urea	DCU
Black Leaf 40®	NICOTINE
BLADEX®	
B-nine	SUCCINIC ACID DIMETHYLHYDRAZIDE
BOMYL®	
Borascu®	BORAX
BORAX	
BORDEAUX MIXTURE	
Boric acid	BORAX
Boro-Spray®	BORAX
Botan®	DCNA
Brestan®	FENTIN ACETATE
BROMACIL	

Name	Refer To
Brominal®	BROMOXYNIL
5-Bromo-3-sec-butyl-6-methyluracil	BROMACIL
3-(4-Bromo-3-chlorophenyl)-1-methoxy-1-methylurea	CHLORBROMURON
O-(4-Bromo-2,5-dichlorophenyl) O,O-diethyl phosphorothioate	BROMOPHOS ETHYL
O-(4-Bromo-2,5-dichlorophenyl) O,O-diethyl phosphorothioate	BROMOPHOS
O-(4-Bromo-2,5-dichlorophenyl)-O-methyl phenylphosphonothioate	LEPTOPHOS
BROMODAN	
Bromofume®	EDP
5-Bromo-3-isopropyl-6-methyluracil	ISOCIL
Bromomethane	METHYL BROMIDE
3-(p-Bromophenyl)-1-methoxy-1-methylurea	METROBROMURON
BROMOPHOS	
BROMOPHOS-ETHYL	
3-Bromo-1-propyne	PROPARGYL BROMIDE
BROMOXYNIL	
BROMOXYNIL, OCTANOATE	
Buctril®	BROMOXYNIL
Bulan®	DILAN®
BUTACHLOR	
Butacide®	PIPERONYL BUTOXIDE
BUTONATE	
Butopyronoxyl USP	BUTYL MESITYL OXIDE OXALATE
Butoxone SB	2-4-DB
2-(2-Butoxyethoxy)ethyl thiocyanate	LETHANE 384
BUTOXY POLYPROPYLENE GLYCOL	
β-Butoxy-β'-thiocyanodiethyl ether	LETHANE 384
2-tert-Butylamino-4-ethylamino-6-methylthio-s-triazine	IGRAN 80W®
BUTYLATE	

Name	Refer To
tert-Butylcarbamic acid ester with 3-(*m*-hydroxyphenyl)-1,1-dimethylurea	KARBUTILATE
Butylcarbityl-6-propylpiperonyl ether (80%) and 20% related compounds	PIPERONYL BUTOXIDE
tert-Butyl-4-(or 5)-chloro-2-methylcyclohexane-carboxylate	TRIMEDLURE
3-tert-Butyl-5-chloro-6-methyluracil	TERBACIL
4-tert-Butyl-2-chlorophenyl methyl O-methylphosphoroamidate	CRUFOMATE
1-Butyl-3-(3,4-dichlorophenyl)-1-methylurea	NEBURON
Butyl 3,4-dihydro-2,2-dimethyl-4-oxo-1-2H-pyran-6-carboxylate	BUTYL MESITYL OXIDE OXALATE
5-Butyl-2-(dimethylamino)-6-methyl-4-hydroxypyrimidine	DIMETHIRIMOL
2-sec-Butyl-4,6-dinitrophenol	DINOSEB
2-sec-Butyl-4,6-dinitrophenyl-isopropyl carbonate	DINOBUTAN
2-sec-Butyl-4,6-dinitrophenyl-3-methyl-2-butenoate	BINAPACRYL
5-Butyl-2-(ethylamino)-4-hydroxy-6-methylpyrimidine	ETHIRIMOL
N-Butyl-N-ethyl-α,α,α-trifluoro-2,6-dinitro-*p*-toluidine	BENEFIN
BUTYL MESITYL OXIDE OXALATE	
2-(*p*-tert-Butylphenoxy)-cyclohexyl-2-propynyl sulfite	PROPARGITE
2-(*p*-tert-Butylphenoxy)-1-methylethyl 2'-chloroethyl sulfite	ARAMITE®
o-SEC-BUTYLPHENYL N-METHYLCARBAMATE	
2-sec-Butylphenyl N-methylcarbamate	*o*-SEC-BUTYLPHENYL N-METHYLCARBAMATE
2-Butyl-4-chloro-*m*-chlorocarbanilate	BARBAN
Butyrac	2-4-DB
Butyrac ester	2-4-DB
Bux	BUX TEN®
BUX TEN®	

Name	Refer To
C-1983	CHLOROXURON
C-6313	CHLORBROMURON
C-6989	FLUORODIFEN
CACODYLIC ACID	
Cadminate	CADMIUM SUCCINATE
CADMIUM-CALCIUM-COPPER-ZINC-SULFATE-CHROMATE COMPLEX	
CADMIUM SUCCINATE	
Calar	CMA
Calcium acid methyl arsenate	CMA
CALCIUM ARSENATE	
CALCIUM CYANAMIDE	
CALCIUM CYANIDE	
Calcium methanearsonate	CMA
Calcium polysulfides and calcium thiosulfate	LIME SULFUR
Calcium propanearsonate	CALCIUM PROPYLARSONATE
CALCIUM PROPYLARSONATE	
Calixin®	TRIDEMORPH
Calo-Clor®	MERCURIC CHLORIDE
Calocure®	MERCURIC CHLORIDE
Cantrol	MCPB
Caparol	PROMETRYNE
Captafol	DIFOLATAN
CAPTAN	
CARBARYL	
CARBETAMIDE	
CARBOFURAN	
2-Carbomethoxy-1-methylvinyl dimethyl phosphate, α isomer	MEVINPHOS
Carbon bisulfide	CARBON DISULFIDE
CARBON DISULFIDE	
CARBON TETRACHLORIDE	
CARBOPHENOTHION	

Name	Refer To
CARBOXIN	
Carbyne®	BARBAN
Carzol®	
Casoron®	DICHLOBENIL
CDAA	
CDAA-T	TCBC
CDEC	
CDT	SIMAZINE
Ceradilla	SABADILLA
Cercobin®	THIOPHANATE®
Ceresan	ETHYLMERCURY CHLORIDE
CERESAN® L	
CERESAN® M	
Ceresan® M-DB	CERESAN® M
Certol®	IOXYNIL
CET	SIMAZINE
Chemathion	MALATHION
Chem Ban®	NABAM
Chem Hoe®	PROPHAM
Chem Neb®	MANEB
Chem-Ox	DINOSEB
Chem Rice®	PROPANIL
Chem-Sen	SODIUM ARSENITE
Chem Star®	ACETIC ACID AND PROPIONIC ACID
Chimosol®	8-QUINOLINOL
Chlonitralid	BAYLUSCIDE®
CHLORAMBEN	
CHLORANIL	
Chlorasol®	ETHYLENE DICHLORIDE
Chlorax®	SODIUM CHLORATE
CHLORAZINE	
CHLOBENSIDE	
CHLORBROMURON	

Name	Refer To
CHLORDANE	
CHLORDIMEFORM	
Chlorex®	DICHLOROETHYL ETHER
Chlorfenson	OVEX
CHLORFENVINPHOS	
CHLORFLURENOL	
Chlorinated camphene with 67-69% chlorine	TOXAPHENE
Chlor Kil®	CHLORDANE
Chlormequat	CYCOCEL®
2-Chloroallyl diethyldithiocarbamate	CDEC
CHLOROBENZILATE	
5-Chloro-2-benzothiazolethiol	5-CHLORO-2-MERCAPTO-BENZOTHIAZOLE
p-Chlorobenzyl-*p*-chlorophenyl sulfide	CHLORBENSIDE
2-Chloro-4,6-bis(diethylamino)-*s*-triazine	CHLORAZINE
2-Chloro-4,6-bis(ethylamino)-*s*-triazine	SIMAZINE
2-Chloro-4,6-bis(isopropylamino)-*s*-triazine	PROPAZINE
4-Chloro-2-butynyl-*m*-chlorocarbanilate	BARBAN
2-Chloro-4-(1-cyan-1-methylethylamino)-6-ethylamino-*s*-triazine	BLADEX
2-Chloro-4-(cyclopropylamino)-6-(isopropylamino)-*s*-triazine	CYPRAZINE
2-Chloro-N,N-diallylacetamide	CDAA
2-Chloro-1-(2,4-dichlorophenyl)-vinyl diethyl phosphate	CHLORFENVINPHOS
O-[2-Chloro-1-(2,5-dichlorophenyl)vinyl] O,O-diethyl phosphorothioate	AKTON®
2-Chloro-4-diethylamino-6-ethylamino-*s*-triazine	BUTACHLOR
2-Chloro-2'-6'-diethyl-N-(*m*-butoxymethyl)acetanilide	PHOSPHAMIDON
2-Chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate	ALACHLOR

Name	Refer To
'-Chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide	GRISEOFULVIN
7-Chloro-4,6-dimethoxycoumaran-3-one-2-spiro-1'(2'-methoxy-6'-methylcyclohex-2'-en'4'-one	ALACHLOR
Chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide	TRIETAZINE
2-Chloro-4-ethylamino-6-isopropylamino-s-triazine	ATRAZINE
2-(4-Chloro-6-ethylamino-s-triazine-2-ylamino)-2-methylpropionitrile	BLADEX®
(2-Chloroethyl)phosphonic acid	ETHEPHON
2-Chloroethyltrimethyl ammonium chloride	CYCOCEL®
Chlorofenson	OVEX
CHLOROFORM	
Chloro IPC	CHLORPROPHAM
2-Chloro-N-(isobutoxymethyl)-2',6'-acetoxylidide	DELACHLOR
2-Chloro-N-isopropylacetanilide	PROPACHLOR
5-CHLORO-2-MERCAPTOBENOTHIAZOLE	
2-Chloro-N-(1-methyl-2-propynyl)-acetanilide	PRYNACHLOR
3'-Chloro-2-methyl-p-valerotoluidine	SOLAN®
CHLORONEB	
O-2-Chloro-4-nitrophenyl O,O-dimethyl phosphorothioate	DICAPTHON
1-Chloro-2-nitropropane	LANSTAN®
Chlorophenothane	DDT
p-Chlorophenoxyacetic acid	4 CPA
3-[p-(p-Chlorophenoxy)phenyl]-1,1-dimethylurea	CHLOROXURON
2-(m-Chlorophenoxy)propionic acid	3-CP
O-(p-(p-CHLOROPHENYLAZO)PHENYL) O,O-DIMETHYL PHOSPHOROTHIOATE	
p-Chlorophenylbenzenesulfonate	FENSON®
p-Chlorophenyl-p-chlorobenzenesulfonate	OVEX
Chlorophenyl)-1,1-hylurea	MONURON

Name	Refer To
3-(4-Chlorophenyl)-1,1-dimethylurea trichloroacetate	MONORON TCA
S-(p-CHLOROPHENYL) O-ETHYL ETHANEPHOSPHONODITHIOATE	
o-Chlorophenyl methylcarbamate	o-CHLOROPHENYL-N-METHYLCARBAMATE
2-Chlorophenyl-N-methylcarbamate	O-CHLOROPHENYL-N-METHYLCARBAMATE
3,(p-Chlorophenyl)-1-methoxy-1-methylurea	MONOLINURON
O-CHLOROPHENYL-N-METHYLCARBAMATE	
Chlorophenyl phenol	ORTHOPHENYLPHENOL
p-Chlorophenyl phenyl sulfone	SULPHENONE
S[(p-Chlorophenyl)thio]methyl O,O-diethyl phosphorodithioate	CARBOPHENOTHION
S-[(p-CHLOROPHENYL)THIO]METHYL O,O-DIETHYL PHOSPHOROTHIOATE	
S-[(p-Chlorophenyl)thio]methyl O,O-dimethyl phosphorodithioate	METHYL TRITHION
[(p-CHLOROPHENYL)THIO](2,4,5-TRICHLOROPHENYL)DIIMIDE	
4-Chlorophenyl-2,4,5-trichlorophenyl azosulfide	[(p-CHLOROPHENYL)-THIO](2,4,5-TRICHLOROPHENYL)-DIIMIDE
p-CHLOROPHENYL-2,4,5-TRICHLOROPHENYL SULFIDE	
4-Chlorophenyl-2,4,5-trichlorophenyl sulfide	p-CHLOROPHENYL-2,4,5-TRICHLOROPHENYL SULFIDE
4-Chlorophenyl 2,4,5-trichlorophenyl sulfone	TETRADIFON
CHLOROPICRIN	
6-Chloropiperonyl chrysanthemumate	BARTHRIN
6-Chloropiperonyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate	BARTHRIN
cis-3-Chloropropenoic acid	SODIUM CIS-3-CHLOROACRYLATE
Chloropropylate®	ACARLATE®
CHLOROTHALONIL	
N'-(4-Chloro-o-tolyl)-N,N-dimethylformamidine	CHLORDIMEFORM
2-[(4-CHLORO-o-TOLYL)OXY]-N-METHOXYACETAMIDE	

Name	Refer To
2-CHLORO-6-TRICHLOROMETHYL PYRIDINE	NITRAPYRIN
2-Chloro-1-(2,4,5-trichlorophenyl)vinyldimethyl phosphate	GARDONA®
CHLOROXURON	
[illegible](and [illegible])-Chloro-3,4-xylylmethylcarbamate	SOK®
Chlorphenamidine	CHLORDIMEFORM
Chlorphos	TRICHLORFON
CHLORPROPHAM	
CHLORPYRIFOS	
Chlortetracycline	SOK®
Cinerin	PYRETHRINS
CIODRIN®	
CIPC	CHLORPROPHAM
Citrazon®	BENZOMATE
Clobber®	CYPROMID
CMA	
Coal tar creosote	CREOSOTE
Copoloid®	COPPER SALTS OF ROSIN and FATTY ACIDS
Copper acetoarsenite	PARIS GREEN
COPPER ARSENATE (BASIC)	
COPPER CARBONATE (BASIC)	
Copper-8-hydroxyquinolinate	COPPER-8-QUINOLINOLATE
Copper meta arsenite copper acetate complex	PARIS GREEN
COPPER NAPHTHENATE	
COPPER OLEATE	
Copper oxinate	COPPER-8-QUINOLINOLATE
COPPER OXYCHLORIDE SULFATE	
COPPER-8-QUINOLINOLATE	
COPPER SALTS OF ROSIN AND FATTY ACIDS	
COPPER SULFATE	
Copper sulfate and hydrated lime mixture	BORDEAUX MIXTURE

Name	Refer To
COPPER ZINC CHROMATE	
Co-Ral®	COUMAPHOS
Corodane®	CHLORDANE
Corothion®	PARATHION
Corrosive sublimate	MERCURIC CHLORIDE
Cotoran®	FLUOMETURON
Coumafene	WARFARIN
Coumafuryl	FUMARIN®
COUMAPHOS	
3-CP	
CP 15336	DIALLATE
4-CPA	
Crab-E-Rad 100®	DSMA
Crag® Fly Repellent	BUTOXYPOLYPROPYLENE GLYCOL
Crag® Fruit Fungicide	GLYODIN®
Crag® Fungicide 658	COPPER ZINC CHROMATE
Crag® Herbicide 1	SESONE
Crag® Herbicide 2	DCU
Crag® Turf Fungicide 531	CADMIUM-CALCIUM-COPPER-ZINC-CHROMATE COMPLEX
CREOSOTE	
Cresols	CREOSOTE
Cresylic acid	CREOSOTE
CRUFOMATE	
CRYOLITE	
m-Cumenyl methylcarbamate	m-ISOPROPYLPHENYL N-METHYLCARBAMATE
o-Cumenyl methylcarbamate	o-ISOPROPYLPHENYL N-METHYLCARBAMATE
Cupric carbonate	COPPER CARBONATE, BASIC
CUPROUS OXIDE	
Cyanamid®	CALCIUM CYANAMIDE
Cyanogas®	CALCIUM CYANIDE
CYANOMETHYLTHIOBENZOTHIAZOLE	
CYANOPHOS	

Name	Refer To
O-p-CYANOPHENYL O-ETHYL PHENYLPHOSPHONOTHIOATE	
O-(p-Cyanophenyl) O,O-dimethyl phosphorothioate	CYANOPHOS
CYANOPHOS	
Cyclic ethylene(diethoxyphosphinyl)-dithioimidocarbonate	CYOLANE®
Cyclic ethylene ester of diethoxyphosphinyl dithioimidocarbonic acid	CYOLANE®
CYCLOATE	
CYCLOHEXIMIDE	
1-(Cyclohexene-1,2-dicarboximido) methyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate	TETRAMETHRIN
3-Cyclohexyl-6,7-dihydro-1H-cyclopentapyrimidine-2,4(3H,5H)-dione	LENACIL
3-Cyclohexyl-5,6-trimethyleneuracil	LENACIL
α-Cyclopropyl-α-(p-methoxyphenyl)-5-pyrimidinemethanol	ANCYMIDOL
CYCOCEL®	
Cygon®	DIMETHOATE
Cynem®	ZINOPHOS®
CYOLANE®	
CYPRAZINE	
Cyprex®	DODINE
CYPROMID	
CYTHIOATE	
Cythion®	MALATHION
Cytrol®	AMITROLE
2,4-D	
D-735	CARBOXIN
Daconil 2787®	CHLOROTHALONIL
Dacthal®	DCPA
DALAPON	
Dasanit®	FENSULFOTHION
DATC	DIALLATE
DAZOMET	
2,4-DB	
DBCP	
DCMU	DIURON
DCNA	
DCPA	
DCPC	DIMITE®
DCU	
D-D®	
DDD	
DDT	
DDVP	DICHLORVOS
Decachlorobis(2,4-cyclopentadiene-1-yl)	PENTAC®
Decachlorooctahydro-1,3,4-methano-2H-cyclobuta-[cd]pentalen-2-one	KEPONE®
n-DECANOL	
Dechlorane	MIREX
DECYLTRIPHENYLPHOSPHONIUM BROMOCHLOROTRIPHENYLSTANNATE	
Dedevap®	DICHLORVOS
Deet	DIETHYLTOLUAMIDE
DEF®	
De-Fol-Ate®	MAGNESIUM CHLORATE
Degreen®	DEF®
DEHYDROACETIC ACID	
DELACHLOR	
Deleaf defoliant	FOLEX®
Delicia	ALUMINUM PHOSPHIDE
Delnav®	DIOXATHION
Delsan®	THRIAM
DEMETON	
Demeton O	DEMETON
Demeton S	DEMETON
Demeton-methyl	METHYL-DEMETON
Demeton-S-methyl	METHYL-DEMETON

Name	Refer To
Demosan®	CHLORONEB
2,4-DEP	
Des-I-Cate	ENDOTHALL
Dessin®	DINOBUTON
DET	DIETHYLTOLUAMIDE
Dethmor®	WARFARIN
DEXON®	
DHA	DEHYDROACETIC ACID
DIALIFOR	
DIALLATE	
N,N-Diallyl-2-chloroacetamide	CDAA
S-(4,6-Diamino-*s*-triazin-2-ylmethyl) 0,0-dimethylphosphorodithioate	MENAZON
Diamond arsonate liquid	MSMA
DIAZINON®	
Dibasic lead arsenate	LEAD ARSENATE
Dibenzo-1,4-thiazine	
Dibrom®	NALED
Dibromochloropropane	DBCP
1,2-Dibromo-2,2-dichloroethyl dimethylphosphate	NALED
1,2-Dibromoethane	EDP
3,5-Dibromo-4-hydroxybenzonitrile	BROMOXYNIL
3,5-Dibromo-4-octanoyloxybenzonitrile	BROMOXYNIL, OCTANOATE
Dibutyl 1,2-benzenedicarboxylate	DI-n-BUTYL PHTHALATE
N,N-Di-n-butyl-*p*-chlorobenzenesulfonamide	ANTIRESISTANT/DDT
3,5-DI-*t*-BUTYLPHENYL METHYLCARBAMATE	
Dibutyl phthalate	DI-*n*-BUTYL PHTHALATE
DI-n-BUTYL PHTHALATE	
Di-n-butyl succinate	TABUTREX®
2,6-Di-tert-butyl-6-tolymethylcarbamate	TERBUTOL
DICAMBA	
DICAPTHON	
DICHLOBENIL	
Dichlofenthion	NEMACIDE
DICHLONE	
Dichloral urea	DCU
Dichloran	DCNA
DICHLORMATE	
S-2,3-Dichloroallyl diisopropyl thiocarbamate	DIALLATE
3,6-Dichloro-*o*-anisic acid	DICAMBA
o-Dichlorobenzene	ORTHODICHLOROBENZENE
p-Dichlorobenzene	PARADICHLOROBENZENE
2,6-Dichlorobenzonitrile	DICHLOBENIL
3,4-Dichlorobenzyl methylcarbamate	DICHLORMATE
1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane	DDD
1,1-Dichloro-2,2-bis(*p*-ethylphenyl)ethane	PERTHANE®
2,4-Dichloro-6(*o*-chloroaniline)-*s*-triazine	DYRENE®
2,4-Dichloro-6(*o*-chloroanilo)-*s*-triazine	DYRENE®
3',4'-Dichlorocyclopropanecarboxanilide	CYPROMID
β,β-Dichlorodiethyl ether	DICHLOROETHYL ETHER
1,4-Dichloro-2,5-dimethoxybenzene	CHLORONEB
Dichloro-dipheny-dichloro-ethane	DDD
Dichloro-diphenyl-trichloro-ethane	DDT
1,2-Dichloroethane	ETHYLENE DICHLORIDE
DICHLOROETHYL ETHER	
DICHLOROMETHANE	
3',4'-Dichloro-2-methylacrylanilide	DICRYL
4,4'-DICHLORO-N-METHYLBENZENESULFONANILIDE	

Name	Refer To
4,4'-Dichloro-γ-methylbenzhydrol	DIMITE®
2,3-Dichloro-1,4-naththoquinone	DICHLONE
2,6-Dichloro-4-nitroaniline	DCNA
2,5-DICHLORO-3-NITROBENZOIC ACID	
1,1-Dichloro-1-nitroethane	ETHIDE®
2',5-Dichloro-4'-nitrosalicylanilide ethanolamine	BAYLUSCIDE®
2,4-Dichlorophenoxyacetic acid,	2,4-D
alkanolamine salt of (of the ethanol and isopropanol series)	
alkylamine (C_{12}) salt of	
alkylamine (C_{13}) salt of	
alkylamine (C_{14}) salt of	
alkylamine (derived from tall oil) salt of	
ammonium salt of	
amylamine salt of	
amyl (pentyl) ester of	
butoxyethanol ester of	
butoxyethoxypropyl ester of	
butoxyethyl ester of	
butoxypolyethoxypropyl ester of	
butoxypropyl ester of	
butyl ester of	
2,4-dichlorophenoxyacetic acid	
4-(2,4-dichlorophenoxy)butyric acid	
diethanolamine salt of	
diethylamine salt of	
diethylethanolamine salt of	
diisopropylamine salt of	
dimethylamine salt of	
N,N-dimethyloleylamine salt of	
dipropylene glycol isobutyl ether ester of	
ethanolamine salt of	
ethoxyethoxyethyl ester of	
ethoxyethoxypropyl ester of	

Name	
2,4-Dichlorophenoxyacetic acid,	2,4-D
ethylamine salt of	
ethylene glycol butyl ether ester of	
ethyl ester of	
heptylamine salt of	
isobutyl ester of	
isooctyl ester of	
isooctyl (2-ethylhexyl) ester of	
isooctyl (2-ethyl-4-methylpentyl) ester of	
isooctyl (2-octyl) ester of	
isopropanolamine salt of	
isopropylamine salt of	
isopropyl ester of	
linoleylamine salt of	
lithium salt of	
methylamine salt of	
methyl ester of	
morpholine salt of	
octylamine salt of	
oleylamine salt of	
N-oleyl-1,3-propylenediamine salt of	
polyethylene glycol ester of	
polypropoxybutyl ester of	
polypropylene glycol ester of	
potassium salt of	
propylamine salt of	
propylene glycol butyl ether ester of	
propylene glycol ester of	
propylene glycol isobutyl ether ester of	
sodium salt of	
tetrahydrofurfuryl ester of	
triethanolamine salt of	

Name	Refer To
2,4-Dichlorophenoxyacetic acid (concluded)	
triethylamine salt of	2,4-D
triisopropanolamine salt of	↓
trimethylamine salt of	
tripropylene glycol isobutyl ether ester of	
γ-(2,4-Dichlorophenoxy)butyric acid, salts, amine salts, and esters	2,4-DB
2,4-Dichlorophenoxyethyl sulfate and sodium salt	SESONE
2-(2,4-Dichlorophenoxy)-propionic acid	DICHLORPROP
0-2,4-Dichlorophenyl-0-0-diethyl phosphorothioate	NEMACIDE
3-(3,5-Dichlorophenyl)-5,5-dimethyl-2,4-oxazolidinedione	DICHLOZOLINE
3-(3,4-Dichlorophenyl)-1,1-dimethylurea	DIURON
2,4-Dichlorophenyl ester of benzenesulfonic acid	GENITE (923)®
3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea	LINURON
0-2,4-Dichlorophenyl 0-methyl Isopropylphosphoramidothioate	DMPA
Di-(*p*-Chlorophenyl)methyl carbinol	DIMITE
2-(3,4-Dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione	METHAZOLE
2,4-Dichlorophenyl *p*-nitrophenyl ester	NITROFEN
α-(2,4-Dichlorophenyl)-α-phenyl-5-pyrimidinemethanol	TRIARIMOL
1,3-Dichloropropene; 3,3-dichloropropene; 1,2-dichloropropane; 2-3-dichloropropene and related C_3 chlorinated hydrocarbons mixture	D-D*
3,4-Dichloropropionanilide	PROPANIL
2,2-Dichloropropionic acid	DALAPON
5,6-Dichloro-2-trifluoromethylbenzimidazole-1-carboxylate	LOVOZAL®
2,2-Dichlorovinyl dimethyl phosphate	DICHLORVOS
DICHLORPROP	
DICHLORVOS	

Name	Refer To
DICHLOZOLINE	
DICOFOL	
Dicrotophos	BIDRIN®
DICRYL	
Dicyclohexylamine salt of dinitro-*o*-cyclohexylphenol	DINITRO-*o*-CYCLOHEXYLPHENOL
DIELDRIN	
0-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] diethyl phosphorothioate	PIRIMIPHOS ETHYL
0-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] dimethyl phosphorothioate	PIRIMIPHOS METHYL
0,0-Diethyl (3-chloro-4-methyl-2-oxo-(2H)-1-benzopyran-7-yl) phosphorothioate	COUMAPHOS
0,0-Diethyl S-[(6-chloro-2-oxobenzoxazolin-3-yl)methyl] phosphorodithioate	PHOSALONE
0,0-Diethyl S-*p*-chlorophenyl thiomethyl phosphorothioate	S-[(*p*-CHLOROPHENYL)-THIO]METHYL 0,0-DIETHYL PHOSPHOROTHIOATE
0,0-Diethyl 0-(2,4-dichlorophenyl) phosphorothioate	NEMACIDE
0,0-Diethyl 0-(2,5-dichloro-4-bromophenyl) phosphorothioate	BROMOPHOS-ETHYL
0,0-Diethyl 0-(2,5-dichloro-4-bromophenyl) thionophosphate	BROMOPHOS-ETHYL
Diethyl 1-(2H-Dichlorophenyl)-2-chlorovinyl phosphate	CHLORFENVINPHOS
Diethyldiphenyldichloroethane	PERTHANE
Diethyl dithiobis(thionoformate)	EXD
0,0-Diethyl S-(N-ethoxycarbonyl-N-methylcarbamoylmethyl) phosphorothiolothionate	MERCARBAM
0,0-Diethyl 0-[2-(ethylthio)-ethyl] phosphorothioate (thiono isomer) and 0,0-diethyl S-[2-(ethylthio)ethyl] phosphorothioate(thiol isomer) mixture	DEMETON
0,0-Diethyl S-[2-(ethylthio)-ethyl] phosphorodithioate	DISULFOTON
0,0-Diethyl S-(ethylthio)-methyl phosphorodithioate	PHORATE

Name	Refer To
0,0-Diethyl 7-hydroxy-3,4-tetramethylene coumarinyl phosphorothioate	2-(2,4-DIHYDROXYPHENYL)-1-CYCLOHEXENE-1-CARBOXYLIC ACID-δ-LACTONE 0,0-DIETHYL PHOSPHOROTHIOATE
0,0-Diethyl S-(N-isopropylcarbamoylmethyl) phosphorodithioate	PROTHATE
0,0-Diethyl 0-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	DIAZINON
0,0-Diethyl 0-[p-(methylsulfinyl)-phenyl] phosphorothioate	DASANIT
0,0-Diethyl S-[4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl] phosphorodithioate	AZINPHOSETHYL
0,0-Diethyl 0-p-nitrophenyl phosphorothioate	PARATHION
Diethyl-4,4'-o-phenylene-bis-(3-thioallaphanate)	THIOPHANATE®
0,0-Diethyl phosphorodithioate S-ester with N-(2-chloro-1-mercaptoethyl)phthalimide	DIALIFOR
0,0-Diethyl 0-(2-pyrazinyl)phosphorothioate	ZINOPHOS®
0,0-Diethyl 0-(3,4-tetramethylene-umbelliferone)phosphorothioate	2-(2,4-DIHYDROXYPHENYL)-10-CYCLOHEXENE-1-CARBOXYLIC ACID-δ-LACTONE 0,0-DIETHYL PHOSPHOROTHIOATE
DIETHYLTOLUAMIDE	
0,0-Diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate	CHLORPYRIFOS
DIFOLATAN®	
Difonate	DYFONATE
2,4-Diguanidino-3,4,6-trihydroxycyclohexyl-5-deoxy-2-0-(2-deoxy-2-methylamino-α-glucopyranosyl)-3-formyl-pentofuranoside	STREPTOMYCIN
2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin	CARBOXIN
2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin-4,4-dioxide	OXYCARBOXIN
2,3-Dihydro-2,2-dimethyl-7-benzofuranyl N-methylcarbamate	CARBOFURAN
6,7-Dihydrodipyrido[1,2a:2',1'-c]pyrazinedium salts	DIQUAT®
1,2-Dihydro-6-ethoxy-2,2,4-trimethylquinoline	ETHOXYQUIN

Name	Refer To
5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide	CARBOXIN
1,2-Dihydro-3,6-pyridazinedione	MH®
2-(2,4-DIHYDROXYPHENYL)-1-CYCLOHEXENE-1-CARBOXYLIC ACID-δ-LACTONE 0,0-DIETHYL PHOSPHOROTHIOATE	
3,5-Diiodo-4-hydroxybenzonitrile	IOXYNIL
S-(0-0-Diisopropyl phosphorodithioate) ester of N-(2-mercaptoethyl)benzene-sulfonamide	BISULFIDE
DILAN®	
Dimecron	PHOSPHAMIDON
DIMEFOX	
DIMETHIRIMOL	
DIMETHOATE	
DIMETHRIN®	
0,S-Dimethyl acetylphosphoramidothioate	ACEPHATE
Dimethylamine salt of polychlorobenzoic acid	PBA
Dimethylamine salt of 2,3,6-trichlorobenzoic acid and other trichlorinated benzoic acids	2,3,6 TBA
p-Dimethylaminobenzenediazo sodium sulfonate	DEXON®
2-(Dimethylamino)-5,6-dimethyl-Δ-pyrimidinyl dimethylcarbamate	PIRIMICARB
m[[(Dimethylamino)methylene]amino]phenyl methylcarbamate hydrochloride	CARZOL®
m[[(Dimethylamino)methylene]amino]phenyl N-methylcarbamate	FORMETANATE
N-Dimethylamino succinamic acid	SUCCINIC ACID DIMETHYLHYDRAZIDE
4-(Dimethylamino)-m-tolyl N-methylcarbamate	MATACIL®
S,S'-[2-(DIMETHYLAMINO)TRIMETHYLENE]BIS(THIOCARBAMATE) HYDROCHLORIDE	
4-Dimethylamino-3,5-xylyl N-methylcarbamate	MEXACARBATE
Dimethylarsinic acid	CACODYLIC ACID

Name	Refer To
2,4-Dimethylbenzyl-2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate	DIMETRIN®
1,1'-Dimethyl-4,4'-bipyridinium-bis-methylsulfate	PARAQUAT
1,1'-Dimethyl-4,4'-bipyridinium dichloride	PARAQUAT
2-Dimethylcarbamyl-3-methyl-5-pyrazolyl dimethylcarbamate	DIMETILAN
O,O-Dimethyl S-p-chlorophenylthiomethyl phosphorothioate	METHYL TRITHION
O,O-Dimethyl O-2,5-dichloro-4-bromophenyl phosphorothioate	BROMOPHOS
O,O-Dimethyl O-2,5-dichloro-4-bromophenyl thionophosphate	BROMOPHOS
2,6-DIMETHYL-3,5-DICHLORO-4-PYRIDINOL	
2-(Dimethylamino)-5,6-dimethyl-4-pyrimidinyl dimethylcarbamate	PIRIMICARB
O,O-DIMETHYL O-(DIMETHYLSULFAMOYL)-PHENYL PHOSPHOROTHIOATE	
N,N-Dimethyl-2,2-diphenylacetamide	DIPHENAMIDE
Dimethyldodecylamine acetate	PENAR®
O,O-Dimethyl S-(N-ethylcarbamoylmethyl) phosphorodithioate	ETHOATEMETHYL
Dimethyl 3-hydroxyglutaconate dimethyl phosphate	BOMYL®
O,O-Dimethyl S-(2-methoxy-1,3,4-thiodiazol-5(4H)onyl-4-methyl phosphorodithioate	METHIDATHION
O,O-Dimethyl S-(N-methyl carbamoylmethyl) phosphorodithioate	DIMETHOATE
O,O-Dimethyl S-(N-methyl-N-formoylcarbamoylmethyl) dithiophosphate	FORMOTHION
N,N-Dimethyl-N'-(2-methyl-4-chlorophenyl)-formamidine	CHLORDIMEFORM
2,2-Dimethyl-3-(2-methyl-propenyl)-cyclopropanecarboxylic ester of N-(hydroxymethyl)-1-cyclohexane-1,2-dicarboximide	NEO-PYAMIN®
DIMETHYL-p-(METHYLTHIO)PHENYL PHOSPHATE	
O,O-Dimethyl-O-[4-(methylthio)-m-tolyl] phosphorothioate	FENTHION
O,O-Dimethyl O-p-nitrophenyl phosphorothioate	METHYL PARATHION

Name	Refer To
O,O-Dimethyl p-nitrophenyl thiophosphate	METHYL PARATHION
O,O-Dimethyl O-(4-nitro-m-tolyl) phosphorodithioate	FENITROTHION
O,O-Dimethyl S-[4-oxo-1,2,3-benzotriazine-3[4H]ylmethyl] phosphorodithioate	AZINPHOSMETHYL
3-[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]glutarimide	CYCLOHEXIMIDE
Dimethyl 4,4'-o-phenylene-bis-(3-thioallophanate)	THIOPHANATE METHYL®
3,4-Dimethylphenyl N-methyl carbamate	3,4-XYLYL METHYLCARBAMATE
1,1-Dimethyl-3-phenylurea	FENURON
Dimethyl phosphate of α-methylbenzyl 3-hydroxy-cis-crotonate	CIODRIN®
Dimethyl phosphate of 3-hydroxy-N,N-dimethyl-cis-crotonamide	BIDRIN®
Dimethyl phosphate of 3-hydroxy-N-methyl-cis-crotonamide	AZODRIN®
O,S-Dimethyl phosphoramidithioate	MONITOR®
O,O-Dimethyl phosphorodithioate of diethyl mercaptosuccinate	MALATHION
N-[(O,O-Dimethylphosphorodithioyl)ethyl]acetamide	S-(2-ACETAMIDOETHYL)-O,O-DIMETHYL PHOSPHORODITHIOATE
DIMETHYL PHTHALATE	
O,O-Dimethyl S-phthalimidomethyl phosphorodithioate	IMIDAN®
O,O-Dimethyl p-sulfamoylphenyl phosphorothioate	CYTHIOATE
Dimethyl-2,3,5,6-tetrachloroterephthalate	DCPA
O,S-DIMETHYL TETRACHLOROTHIOTEREPHTHALATE	
DIMETHYLTHIOCARBONYL DISULFIDE	
O,O-Dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphonate	TRICHLORFON
Dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphate ester of butyric acid	BUTONATE
O,O-Dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate	RONNEL
Dimethyl 3,5,6-trichloro-2-pyridyl phosphate	FOSPRIATE

Name	Refer To
2,6-Dimethyl-4-tridecylmorpholine	TRIDEMORPH
1,1-Dimethyl-3(α,α,α-trifluoro-*m*-tolyl)urea	FLUOMETURON
m-(3,3-Dimethylureido)phenyl tert-butylcarbamate	KARBUTILATE
DIMETILAN	
DIMITE®	
Dinitrocresol	DNOC
Dinex®	DINITROCYCLOHEXYLPHENOL
4,6-Dinitro-2-sec-butylphenol	DINOSEB
4,6-Dinitro-2-sec-butylphenyl acetate	DINOSEB ACETATE
DINITROCYCLOHEXYLPHENOL	
2,6-Dinitro-N,N-dipropylcumidine	ISOPROPALIN
3,5-Dinitro-N^4,N^4-dipropylsulfanilamide	ORYZALIN
4,6-Dinitrophenol-O-sec-butylphenol	DINOSEB
3,5-Dinitro-*o*-toluamide	ZOALENE
2,4'-Dinitro-4-trifluoromethyl-diphenylether	FLUORODIFEN
Dinoben®	2,5-DICHLORO-3-NITRO-BENZOIC ACID
DINOBUTON	
Dinocap®	KARATHANE®
DINOSEB	
DINOSEB ACETATE	
2,3-*p*-Dioxanedithiol-S,S-bis-(O,O-diethyl phosphorodithioate)	DIOXATHION
DIOXATHION	
Diphacin®	DIPHACINONE
DIPHACINONE	
DIPHENAMID	
DIPHENATRILE	
Diphenyl	BIPHENYL
Diphenylacetonitrile	DIPHENATRILE
2-Diphenylacetyl-1,3-indandione	DIPHACINONE
DIPHENYLAMINE	

Name	Refer To
DIPHENYLAMMONIUM PROPIONATE	
Diphenyl diimide	AZOBENZENE
Dipropyl isocinchomeronate	MGK REPELLENT 326®
Di-n-propylmaleate isosafrole condensate	PROPYL ISOME
Di-n-propyl 6,7-methylene-dioxy-3-methyl-1,2,3,4-tetrahydro-naphthalene-1,2-dicarboxylate	PROPYL ISOME
Dipterex®	TRICHLORFON
DIQUAT®	
Disodium arsenate	SODIUM ARSENATE
DISODIUM CYANODITHIOIMIDOCARBONATE	
Disodium ethylenebisdithiocarbamate	NABAM
Disodium methanearsonate	DSMA
DISUGRAN	
DISULFOTON	
Disul-sodium	SESON
Di-Syston®	DISULFOTON
DiTac	DSMA
Dithane A-40®	NABAM
Dithane D14®	NABAM
Dithane M-22®	MANEB
DITHANE M-45®	
DITHANE S-31®	
Dithane Z-78®	ZINEB
Dithiosystox	DISULFOTON
Ditranil	DCNA
DIURON	
DMA-4®	2,4-D
DMA-100	DSMA
DMC	DIMITE®
DMDT	METHOXYCHLOR
DMP	DIMETHYL PHTHALATE
DMPA	
DMSA	SUCCINIC ACID DIMETHYL-HYDRAZIDE

Name	Refer To
DMTT	DAZOMET
DMU	DIURON
DN 111® (dicyclohexylamine salt)	DINITROCYCLOHEXYLPHENOL
DNBP	DINOSEB
DNPB	DINOSEB
DNC	DNOC
DN Dry Mix No. 1	DINITROCYCLOHEXYLPHENOL
DNOC	
DNOCHP	DINITROCYCLOHEXYLPHENOL
DNOSBP	DINOSEB
Dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta[cd]-pentalene	MIREX
Dodecylguanidine acetate	DODINE
DODINE	
Dowfume®	ETHYLENE DICHLORIDE
Dowfume MC	METHYL BROMIDE
Dowfume® W-85	EDB
Dowicide A®	ORTHOPHENYLPHENOL
Dowpon®	DALAPON
2-4 DP	DICHLOROPROP
Dri-Die®	SILICA GEL
Drinox®	ALDRIN
Drinox H-34	HEPTACHLOR
Drop-Leaf®	SODIUM CHLORATE
DSMA	
D-TRANS ALLETHRIN®	
Dursban®	CHLORPYRIFOS
Du-Ter®	TRIPHENYLTIN HYDROXIDE
Dyanap (mixed with DNBP)	NAPTALAM
Dybar®	FENURON
DYFONATE®	
Dylox®	TRICHLORFON
DYRENE®	
Dymid®	DIPHENAMID
E-605	PARATHION

Name	Refer To
Easy Off-D®	FOLEX®
EDB	
EDC	ETHYLENE DICHLORIDE
EGT	
ELCIDE® 73	
Elgetol®	DNOC
EMMI®	
Enide®	DIPHENAMID
ENDOSULFAN	
ENDOTHALL	
ENDOTHION	
ENDRIN	
Entex®	FENTHION
EP-332	CARZOL®
EPN®	
1,2-Epoxypropane	PROPYLENE OXIDE
Eptam®	EPTC
EPTC	
ERADEX®	
Erazidon®	ERADEX®
ERBON	
ETHEPHON	
ETHIDE®	
ETHIOLATE	
ETHION	
ETHIRIMOL	
ETHOATE-METHYL	
Ethohexadiol	ETHYLHEXANEDIOL
6-Ethoxy-1,2-dihydro-2,2,4-trimethylquinoline	ETHOXYQUIN
ETHOXYQUIN	
5-Ethoxy-3-trichloromethyl-1,2,4-thiadiazole	TERRAZOLE®

Name	Refer To
2-(Ethylamino)-4-(isopropylamino)-6-methoxy-s-triazine	ATRATRONE
2-(Ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine	AMETRYNE
Ethyl O-benzoyl-3-chloro-2,6-dimethyloxybenzohydroximate	BENZOMATE
S-[(Ethylcarbamoyl)methyl] 0,0-dimethyl phosphorodithioate	ETHOATE-METHYL
O-Ethyl S-4-chlorophenyl ethylphosphonodithioate	S-(p-CHLOROPHENYL)-O-ETHYL ETHANEPHOSPHONODITHIOATE
S-Ethyl cyclohexylethylthiocarbamate	CYCLOATE
Ethyl 4,4'-dichlorobenzilate	CHLOROBENZILATE
S-Ethyl diethylthiocarbamate	ETHIOLATE
S-Ethyl diisobutylthiocarbamate	BUTYLATE
O-Ethyl S,S-dipropyl phosphorodithioate	PROPHOS
S-Ethyl dipropylthiocarbamate	EPTC
ETHYLENE	
Ethylene dibromide	EDB
ETHYLENE DICHLORIDE	
Ethyleneglycol bis(trichloroacetate)	EGT
ETHYLENE OXIDE	
3,3'Ethylene bis(tetrahydro-4,6-dimethyl-2H-1,3,5-thiadiazine-2-thione)	MILNEB
Ethyl ester of 0,0-dimethyldithiophosphoryl α-phenyl acetic acid	ETHYL MERCAPTOPHENYLACETATE, 0,0-DIMETHYL PHOSPHORODITHIOATE
S-Ethyl N-ethyl-n-cyclohexylthiocarbamate	CYCLOATE
ETHYL FORMATE	
Ethyl guthion	AZINPHOSETHYL
S-Ethylhexahydro-1H-azepine-1-carbothioate	MOLINATE
ETHYL HEXANEDIOL	
N-(2-Ethylhexl)bicyclo[2.2.1]-5-heptene-2,3-dicarboxamide	MGK264®
Ethylhydrogen 1-propylphosphonate	NIA10637
D-N-Ethyllactamide carbanilate (ester)	CARBETAMIDE

Name	Refer To
Ethyl mercaptophenylacetate, 0,0-dimethyl phosphorodithioate	PHENTHOATE
ETHYLMERCURIC PHOSPHATE	
ETHYLMERCURY CHLORIDE	
N-(Ethylmercury)-p-toluene-sulfonanilide	CERESAN M®
O-Ethyl-O-p-nitrophenyl phenylphosphonothioate	EPN®
Ethyl parathion	PARATHION
O-Ethyl-S-phenyl-ethylphosphonodithioate	DYFONATE®
m(1-Ethylpropyl)phenyl N-methylcarbamate	BUX TEN®
S-Ethylthioethyl 0,0-dimethyl phosphorodithioate	S-[(2-(ETHYLTHIO)ETHYL)] 0,0-DIMETHYL PHOSPHORODIOTHIOATE
S-[(2-(ETHYLTHIO)ETHYL)] 0,0-DIMETHYL PHOSPHORODIOTHIOATE	
O-[2-(Ethylthio)ethyl] 0,0-dimethylphosphorothioate	METHYL-DEMETON
S-[2-(Ethylthio)ethyl] 0,0-dimethylphosphorothioate	METHYL-DEMETON
EVIK®	AMETRYNE
EYD	
E-Z-Off®	MAGNESIUM CHLORATI
E-Z-Off D®	DEF®
F-461	OXYCARBOXIN
Fall®	SODIUM CHLORATE
Falodin	2,4-DEP
Falone®	2,4-DEP
Famophos	0,0-DIMETHYL O-p-(DIMETHYL SULFAMOYL)-PHENYL PHOSPHOROTHIOATE
Famphur	0,0-DIMETHYL O-p-(DIMETHYL SULFAMOYL)-PHENYL PHOSPHOROTHIOATE
Far-Go®	TRIALLATE
FENAC®	
Fen-All®	2,3,6 TBA
FENITROTHION	

Name	Refer To
Fenchlorfos	RONNEL
FENSON®	
FENSULFOTHION	
FENTHION	
FENTIN ACETATE	
FENURON	
FENURON TCA	
Fenzaflor	LOVOZAL®
FERBAM	
Fermate®	FERBAM
Ferric dimethyl dithiocarbamate	FERBAM
Flit MLO®	PETROLEUM OILS
Floraltone®	TIBA
FLUOMETURON	
FLUORODIFEN	
2-FLUORO-N-METHYL-N-(1-NAPHTHYL) ACETAMIDE	
FOLEX®	
Folidol	PARATHION
Folidol M®	METHYLPARATHION
Folithion®	FENITROTHION
Folosan®	TETRACHLORONITROBENZENE
FOLPET	
FORMALDEHYDE	
Formalin	FORMALDEHYDE
FORMETANATE	
Formetanate Hydrochloride	CARZOL®
FORMOTHION	
S-[(Formylmethylcarbamoyl)methyl] O,O-dimethyl phosphorodithioate	FORMOTHION
FORTIFIED	BHC
Forturf®	DACONIL 2787®
Fos-Fall "A"	DEF®
FOSPRIATE	
Fruitone	4-CPA
Fuklasin	ZIRAM
FUMARIN®	
Fumazone®	DBCP
Fundal	CHLORDIMEFORM
Furadan®	CARBOFURAN
Fusarex®	TETRACHLORINITROBENZENE
F-W-925	NITROFEN
G-30028	PROPAZINE
G-32293	ATRATRONE
G-34161	PROMETRYNE
Galecron®	CHLORDIMEFORM
Gallotox®	PMA
Gamma BHC	LINDANE
Gammexane®	BHC
GARDONA®	
GENITE (923)®	
Genitol	GENITE (923)®
Genitox®	DDT
Gesagard	PROMETRYNE
Gesamil®	PROPAZINE
Gesaprim®	ATRAZINE
Gesapum®	SIMAZINE
Gesatamine	ATRATRONE
GIBBERELLIC ACID	
Gibberellin	GIBBERELLIC ACID
GLYODIN®	
Glyoxide®	GLYODIN®
GLYPHOSATE	
GLYPHOSINE	
Glytac®	EGT
Goldcrest®	CHLORDANE
Goodrite ZIP	ZIRAM
GOPHACIDE®	
Granosan®	ETHYLMERCURY CHLORIDE

Name	Refer To
Granosan L	CERESAN L®
GRISEOFULVIN	
GS 14260	IGRAN 80W®
Gusathion®	AZINPHOSMETHYL
Guthion®	AZINPHOSMETHYL
Hanane	DIMEFOX
HC-1281®	2,3,6 TBA
HCA	
HCB	
HEPTACHLOR	
1,4,5,6,7,8,8a-Heptachloro-3a, 4,7a-tetrahydro-4,7-methanoidene	HEPTACHLOR
2-Heptadecylimidazoline acetate	GLYODIN®
Herban®	NOREA
Herbicide 273®	ENDOTHALL
Herbicide 282®	ENDOTHALL
Herbisan®	EXD
Hercules 7531	NOREA
Herkol®	DICHLORVOS
Hexachloroacetone	HCA
Hexachlorobenzene	HCB
1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo exo-5,8-dimethanonaphthalene	DIELDRIN
1,2,3,4,5,6-Hexachlorocyclohexane containing at least 99% γ isomer	LINDANE
1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthalene	ENDRIN
3,4,5,6,7,7-Hexachloro-N-(ethylmercuri)-1,2,3,6-tetrahydro-3,6-endo-methanophthalimide	EMMI®
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene	ALDRIN
6,7,8,9,10,10-Hexachloro-1,5,5a,6,-9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide	ENDOSULFAN

Name	Refer To
3,4,5,6,7,7-Hexachloro-N-(methylmercuri)-1,2,3,6-tetrahydro-3,6-endomethanophthalimide	MEMMI®
HEXACHLOROPHENE	
2,4-Hexadienoic acid	SORBIC ACID
HEXAFLURATE	
3-(Hexahydro-4,7-methanoinden-5-l)-1,1-dimethylurea	NOREA
Hoe 2747	MONOLINURON
Hoe 2904	DINOSEB ACETATE
Hormodin®	INDOLEBUTYRIC ACID
Hydrocyanic acid	HYDROGEN CYANIDE
HYDROGEN CYANIDE	
Hydrothal	ENDOTHALL
2-Hydroxyethyl-n-octyl sulfide	MGK REPELLENT 874®
2-Hydroxybiphenyl	ORTHOPHENYL PHENYL
HYDROXYMERCURICHLOROPHENOL	
Hydroxymercurinitrophenol	SEMESAN BEL®
2-HYDROXYPROPYLMETHANETHIO SULFONATE	
5-(α-Hydroxy-α-2-pyridyl-enzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide	NORBORMIDE
8-Hydroxyquinoline sulfate	8-QUINOLINOL
Hydroxytriphenyltin	TRIPHENYLTIN HYDROXIDE
Hyvar®	BROMACIL
IGRAN 80W®	
IMIDAN®	
Indalone®	BUTYL MESITYL OXIDE OXALATE
INDOLEBUTYRIC ACID	
IOXYNIL	
IPC	PROPHAM
Isobenzan	TELODRIN
Isobornyl thiocyanoacetate	THANITE®

Name	Refer To
ISOCIL	
ISODRIN	
ISOPROPALIN	
2-Isopropoxyphenyl-N-methylcarbamate	BAYGON®
3-Isopropyl-1H-2,1,3-Benzothiadiazin-(4)3H-one 2,2-dioxide	BENTAZON
Isopropyl-m-chlorocarbanilate	CHLORPROPHAM
Isopropyl 4,4'-dichlorobenzilate	ACARALATE®
Isopropyl diethyldithiophosphorylacetamide	PROTHOATE
Isopropyl (2E,4E)-11-methoxy-3,7,-11-trimethyl-2,4-dodecadienoate	METHOPRENE
3-Isopropyl-5-methylphenyl N-methylcarbamate	PROMECARB
Isopropyl N-phenylcarbamate	PROPHAM
5-Isopropyl-m-tolyl N-methylcarbamate	PROMECARB
Isopropyl xanthic acid and its sodium salt	SODIUM ISOPROPYL XANTHATE
m-ISOPROPYLPHENYL N-METHYLCARBAMATE	
o-ISOPROPYLPHENYL N-METHYLCARBAMATE	
Isotox®	BHC
2-ISOVALERYL-1,3-INDANDIONE	
Ivosit®	DINOSEB ACETATE
Jasmolin	PYRETHRINS
KARATHANE®	
KARBUTILATE	
Karmex®	DIURON
Kelthane	DICOFOL
Kemate	DYRENE®
KEPONE®	
Kloben®	NEBURON
KOCN	
Korax	LANSTAN®
Korlan®	RONNEL

Name	Refer To
Kryocide®	CRYOLITE
Kuron®	SILVEX
Kurosal®	SILVEX
Lambast®	MPMT
LANDRIN®	
Lannate®	METHOMYL
LANSTAN®	
Larvacide®	CHLOROPICRIN
Larvatrol®	BACILLUS THURINGIENSIS
Lasso®	ALACHLOR
LEAD ARSENATE	
Lebaycid	FENTHION
LENACIL	
LEPTOPHOS	
LETHANE 384	
LIME SULFUR	
Limit®	CDAA
LINDANE	
Lintox®	BHC
LINURON	
Liquiphene	PMA
LM seed protectant	ORTHO LM
Lonacol®	ZINEB
LONDON PURPLE	
Lorox®	LINURON
LOVOZAL®	
MAA	DSMA
Machete®	BUTACHLOR
Mafu	DICHLORVOS
MAGNESIUM ARSENATE	
MAGNESIUM CHLORATE	
Magron®	MAGNESIUM CHLORATE
Malachite green	COPPER CARBONATE, BASIC
Malaspray®	MALATHION

Name	Refer To
MALATHION	
Maleic hydrazide	MH®
Maloran®	CHLORBROMURON
MAMA	
Mancozeb	DITHANE M-45
MANEB	
Manganese dimethyl dithiocarbamate and mercaptobenzothiazole	NIACIDE®
Manganous ethylene bisdithiocarbamate	MANEB
Manzate®	MANEB
Marlate®	METHOXYCHLOR
MATACIL®	
MBC®	SODIUM CHLORATE
MCA 600®	MOBAM®
MCP	MCPA
MCPA	
MCPB	
MCPP	
MEB	MANEB
MECARBAM	
Mecopar	MCPP
Mecopex®	MCPP
Mecoprop	MCPP
MEMMI®	
MENAZON	
Meobal®	3,4-XYLYL N-METHYLCARBAMATE
Mephanac®	MCPA
2-MERCAPTOBENZOTHIAZOLE	
2-Mercaptobenzothiazole of manganese dimethyl dithiocarbamate	NIACIDE®
Mercaptodimethur	MESUROL®
N-(Mercaptomethyl)phthalimide S-(O,O-dimethyl)phosphorodithioate	IMIDAN®
Mercaptophos	DEMETON
Mercuram®	THIRAM

Name	Refer To
Mercuric chloride	MERCURY CHLORIDES
MERCURIC DIMETHYLDITHIOCARBAMATE	
Mercurous chloride	MERCURY CHLORIDES
Merphos®	FOLEX®
Mertect®	THIABENDAZOLE
Merthiolate®	ELCIDE® 73
MESUROL®	
Metacate	m-TOLYL N-METHYLCARBAMATE
METALDEHYDE	
Metam	METHAM
Meta-Systox®	METHYL-DEMETON
METHAM	
Methanearsonic acid	DSMA
Methar	DSMA
METHAZOLE	
METHIDATHION	
METHOMYL	
METHOPRENE	
Methoxone®	MCPA
2-METHOXY-4H-1,3,2-BENZODIOXAPHOSPHORIN 2-SULFIDE	
1-Methoxycarbonyl-1-propen-2-yl dimethylphosphate, and its β isomer	MEVINPHOS
METHOXYCHLOR	
Methoxy DDT	METHOXYCHLOR
S-[[(2-Methoxyethyl)carbamoyl]-methyl] O,O-dimethyl phosphorodithioate	AMIDITHION
S-[(5-Methoxy-4-oxo-4H-pyran-2-yl)methyl] O,O-dimethylphosphorothioate	ENDOTHION
2-Methylbenzyl 3-(dimethoxyphosphinyloxy)-cis-crotonate	CIODRIN®
METHYL BROMIDE	
Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate	BENOMYL

Name	**Refer To**
m-(1-Methylbutyl)phenyl N-methylcarbamate	BUX TEN®
Methyl chloroform	1,1,1-TRICHLOROETHANE
Methyl 2-chloro-9-hydroxyfluorene-9-carboxylate	CHLORFLURENOL
2-Methyl-4-chlorophenoxyacetic acid	MCPA
4-(2-Methyl-4-chlorophenoxy) butyric acid	MCPB
2-(2-Methyl-4-chlorophenoxy) propionic acid	MCPP
1-(2-Methylcyclohexyl)-3-phenylurea	SIDURON
METHYL-DEMETON	
Methyl 3,6-dichloro-*o*-anisate	DISUGRAN
Methyl 3,4-dichlorocarbanilate	SWEP
2-Methyl-4,6-dinitrophenol sodium salt	DNOC
2,2-Methylene bis(3,4,6-trichlorophenol)	HEXACHLOROPHENE
1,2-Methylenedioxy-4-[2-(octylsulfinyl)propyl]benzene	SULFOXIDE
Methylene chloride	DICHLOROMETHANE
1-(N-Methylfluoroacetamido)-naphthalene	2-FLUORO-N-METHYL-N-(1-NAPHTHYL)ACETAMIDE
Methyl N',N'-Dimethyl-N-[(methylcarbamoyl)oxy]-1-thiooxamimidate	OXAMYL
2-(1-Methylheptyl)-4,6-dinitrophenyl crotonate	KARATHANE®
Methyl *m*-hydroxycarbamanilate *m*-methylcarbanilate	PHENMEDIPHAM
3-Methyl-5-isopropylphenyl-N-methylcarbamate	PROMECARB
Methylisothiocyanate, chloropicrin and chlorinated C_3 hydrocarbons	VORLEX®
METHYL MERCURIC HYDROXIDE	
3-METHYL-(MERCURITHIO)-1,2-PROPANEDIOL	
Methyl mercury dicyandiamide	PANOGEN
Methylmercury 2,3-dihydroxpropyl mercaptide and methylmercury acetate mixture	CERESAN L®

Name	**Refer To**
Methylmercury 8-hydroxyquinolate	ORTHO LM
METHYLMERCURY NITRILE	
S-Methyl N-[(methylcarbamoyl)-oxy]thioacetimidate	METHOMYL
1-Methyl-2-(3,4-methylenedioxyphenyl)ethyl octyl sulfoxide	SULFOXIDE
2-Methyl-2-(methylthio)propionaldehyde O-methylcarbamoyl)oxime	ALDICARB
N-Methyl-N-(1-naphthyl)-monofluoroacetamide	2-FLUORO-N-(1-NAPHTHYL) ACETAMIDE
METHYL NONYL KETONE	
METHYL PARATHION	
3-Methylphenyl N-methylcarbamate	*m*-TOLYL N-METHYL CARBAMATE
3-(2-Methylpiperidino)propyl-3,4-dichlorobenzoate	PIPRON
3-(1-Methyl-2-pyrrolidyl)-pyridine	NICOTINE
6-Methyl-2,3-quinoxalinedithiol cyclic, S,S-dithiocarbonate	MORESTAN®
Methyl sulfanilylcarbamate	ASULAM
4-(Methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline	NITRALIN
METHYL-2,3,5,6-TETRACHLORO-N-METHOXY-N-METHYLTEREPHTHALAMATE	
4-(Methylthio)-3,5-xylymethylcarbamate	MESUROL®
METHYL TRITHION	
Meticide®	METHYL PARATHION
Metmercapturon	MESUROL®
METOBROMURON	
Metron®	METHYL PARATHION
MEVINPHOS	
MEXACARBATE	
MGK 264®	
MGK REPELLENT 11®	
MGK REPELLENT 326®	

Name	Refer To
MGK REPELLENT 874®	
MH®	
MH-30®	MH®
Micro-Fume®	DAZOMET
Milbam	ZIRAM
Milcurb®	DIMETHIRIMOL
Mildex®	KARATHANE®
Miller 531®	CADMIUM-CALCIUM-COPPER-ZINC-CHROMATE COMPLEX
Mil134 658	COPPER ZINC CHROMATE
MILNEB	
Milogard®	PROPAZINE
Milstem®	ETHIRIMOL
Mineral oil	BAYGON®
MIREX	
MnEBD	MANEB
MNK	METHYL NONYL KETONE
MOBAM®	
Mocap®	PROPHOS
MOLINATE	
MONITOR®	
Monoammonium methylarsenate	MAMA
Monoborochlorate	SODIUM CHLORATE
Monocrotophos	AZODRIN®
N-Monoethylamide of O,O-dimethyldithiophosphonyl acetic acid	S-[(ETHYLCARBAMOYL)-METHYL] O,O-DIMETHYL PHOSPHORODITHIOATE
MONOLINURON	
Monosodium acid methanearsonate	MSMA
MONURON	
MONURON TCA	
MORESTAN®	
Morkit®	ANTHRAQUINONE
Morocide®	BINAPACRYL
Morsodren®	PANOGEN®
Moxie®	METHOXYCHLOR
MPMT	
MSMA	
Murfotox®	MERCARBAM
Murtox®	MERCARBAM
Murvesco®	FENSON®
Muscatox®	COUMAPHOS
Mylone®	DAZOMET
N-2790	DYFONATE®
NAA	NAPHTHALENE ACETIC ACID
NABAM	
NALED	
Nankor®	RONNEL
NAPHTHALENE	
NAPHTHALENE ACETAMIDE	
NAPHTHALENE ACETIC ACID	
1,8-NAPHTHALIC ANHYDRIDE	
Naphthenic acids, copper salts	COPPER NAPHTHENATE
β-NAPHTHOXYACETIC ACID	
2-Naphthoxyacetic acid	β-NAPHTHOXYACETIC ACID
O-(2-Naphthyl)glycolic acid	β-NAPHTHOXYACETIC ACID
1-Naphthyl N-methylcarbamate	CARBARYL
N-1-Naphthylphthalamic acid	NAPTALAM
α-Naphthythiourea	ANTU®
NAPTALAM	
Navadel®	DIOXATHION
NC 5016	LOVOZAL®
NEBURON	
Neguvon®	TRICHLORFON
NEMACIDE	
Nemafos®	ZINOPHOS
Nemagon®	DBCP
Nemax®	CHLOROPICRIN

Name	Refer To
Nemex®	D-D®
Neobor®	BORAX®
NEO-PYNAMIN®	
NIA 5961	LANSTAN®
NIA 10637	
NIACIDE®	
Niagaramite®	ARAMITE®
Nialate®	ETHION
Nickel sulfate and manganous ethylene-bis (dithiocarbamate)	DITHANE S-31®
NICOTINE	
Nicotine sulfate	NICOTINE
NIP	NITROFEN
Niran®	PARATHION
NITRALIN	
NITRAPYRIN	
NITROBENZENE	
Nitrobenzol	NITROBENZENE
2-Nitro-1,1-bis(p-chlorophenyl) butane and 2-nitro-1,1-bis (p-chlorophenyl) propane	DILAN®
NITROFEN	
p-Nitrophenyl α,α,α-trifluoro-2-nitro-p-tolyl ether	FLUORODIFEN
p-Nitrophenyl 2-nitro-4-[trifluoromethyl]phenyl ether	FLUORODIFEN
NoBunt 40 or 80®	HCB
Nomersan®	THIRAM
NORBORMIDE	
NOREA	
Novege®	ERBON
NPA	NAPTALAM
NPD®	ASPON®
Octachloro-4,7-methanotetrahydroindane (60%) and related compounds (40%) mixture	CHLORDANE
Octacide 264	MGK 264®
Octalox®	DIELDRIN
Octamethylpryophosphoramide	SCHRADAN
n-OCTANOL	
N-Octylbicycloheptenedicarboximide	MGK 264®
n-Octyl sulfoxide of isosafrole	SULFOXIDE
Off Shoot-T®	n-OCTANOL and n-DECANOL
Oko®	DICHLORVOS
Omite®	PROPARGITE
OMPA	SCHRADAN
OPP	ORTHOPHENYLPHENOL
Ordram®	MOLINATE
Orthene®	ACEPHATE
Orthoarsenic acid	ARSENIC ACID
Ortho 5353	BUX TEN®
Ortho 9006	MONITOR®
Orthocide®	CAPTAN
ORTHODICHLOROBENZENE	
Ortho Dual Paraquat	PARAQUAT
Ortho-Klor®	CHLORDANE
ORTHO LM	
Ortho MC®	MAGNESIUM CHLORATE
Ortho Paraquat Chloride	PARAQUAT
ORTHOPHENYLPHENOL	
Orthophos	PARATHION
Ortho phosphate defoliant	DEF®
Orthoxenol	ORTHOPHENYLPHENOL
ORYZALIN	
Osbac®	o-sec-BUTYLPHENYL N-METHYLCARBAMATE
Outfox®	CYPRAZINE
OVEX	
Ovotran®	OVEX
7-Oxabicyclo-(2.2.1)-heptane-2,3-dicarboxylic acid	ENDOTHALL

Name	Refer To
OXAMYL	
Oxime	8-QUINOLINOL
Oxirane	ETHYLENE OXIDE
OXYCARBOXIN	
OXYDEMETON METHYL	METHYL DEMETON
Oxythioquinox	MORESTAN®
Paarlan®	ISOPROPALIN
Pandrinox®	PANOGEN®
Panodrin A13®	PANOGEN®
PANOGEN®	
Panoram D-31	DIELDRIN
Panterra®	PANOGEN®
Panthion®	PARATHION
PARADICHLOROBENZENE	
PARAQUAT	
PARATHION	
Parawet®	PARATHION
Parazate	ZINEB
PARINOL	
PARIS GREEN	
PAS	
Patoran®	METOBROMURON
PBA	
PCNB	
PCP	
PEBC	PEBULATE
PEBULATE	
PENAR®	
Penphene	TCTP
Penta	PCP
PENTAC®	
Pentachloronitrobenzene	PCNB
(Z)-2,3,5,5,5-Pentachloro-4-oxo-2-pentenoic acid	ALORAC

Name	Refer To
Pentachlorophenol	PCP
Perchloroethylene	TETRACHLOROETHYLENE
Perchlorobenzene	HCB
PERTHANE®	
Pestan	MECARBAM
Pestermaster® EDB-85	EDB
Pestox 14®	DIMEFOX
PETD	POLYETHYLENE THIURAM DISULFIDE
PETROLEUM OILS	
Phaltan	FOLPET
PHENMEDIPHAM	
Phenotan®	DINOSEB ACETATE
PHENOTHIAZINE	
Phenthiazine	PHENOTHIAZINE
PHENTHOATE	
3-Phenyl-1,1-dimethylurea	FENURON
3-Phenyl-1,1-dimethylurea trichloroacetate	FENURON TCA
Phenyl hydroxymercury	PHENYLMERCURIC HYDROXIDE
2-(PHENYLMERCURIAMINO)ETHYL ACETATE	
Phenylmercuric acetate	PMA
PHENYLMERCURIC AMMONIUM ACETATE	
PHENYLMERCURIC BORATE	
PHENYLMERCURIC DIMETHYLDITHIOCARBAMATE	
PHENYLMERCURIC HYDROXIDE	
PHENYLMERCURIC LACTATE	
PHENYLMERCURIC NAPHTHENATE	
PHENYLMERCURIC OLEATE	
PHENYLMERCURIC PROPIONATE	
Phenylmercuric triethanol ammonium lactate	PAS
N-PHENYLMERCURIFORMAMIDE	
PHENYLMERCURY UREA	

Name	Refer To
N-PHENYL-2-NITROPROPYL PIPERIDINE	
o-Phenylphenol	ORTHOPHENYLPHENOL
2-Phenylphenol	ORTHOPHENYLPHENOL
Phix®	PMA
PHORATE	
PHOSALONE	
Phosdrin®	MEVINPHOS
PHOSFON®	
Phoskil®	PARATHION
PHOSPHAMIDON	
Phosphoric acid, 2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl ester	GARDONA®
Phosphorothioic acid, O-[2-chloro-1-(2,5-dichlorophenyl) vinyl]O,O-diethyl ester	
Phostoxin®	ALUMINUM PHOSPHIDE
Phthalthrin	NEO-PYAMIN®
Phygon®	DICHLONE
Phytar 560	CACODYLIC ACID
Picfume®	CHLOROPICRIN
PICLORAM	
Pindone	PIVAL®
Piperaline	PIPRON
Piperonal bis[2-(2'-n-butoxyethyl)ethyl]acetal	TROPITAL®
PIPERONYL BUTOXIDE	
N-(PHOSPHONOMETHYL) GLYCINE	GLYPHOSATE
PIPERONYL CYCLONENE	
PIPRON	
PIRIMICARB	
PIRIMIPHOS ETHYL	
PIRIMIPHOS METHYL	
Pirimor®	PIRIMICARB
PIVAL®	

Name	Refer To
2-Pivalyl-1,3-indanione	PIVAL®
Pivalyn®	PIVAL®
Planavin®	NITRALIN
Plantvax®	OXYCARBOXIN
PMA	
PMAS	PMA
PMP	2-ISOVALERYL-1,3-INDANDIONE
POLYACRYLONITRILE, HYDROLYZED, SODIUM SALT	
Polybor 3®	BORAX
Polybor chlorate	SODIUM CHLORATE
Polychlorobenzoic acid	PBA
Polychloribicyclopentadiene isomers	BANDANE®
Polychloro-tetrahydro-methanoindene	BANDANE®
POLYETHYLENE POLYSULFIDE	
POLYETHYLENE THIURAM DISULFIDE	
POLYRAM®	
Pomarsol®	THIRAM
Pomarsoltz®	ZIRAM
Potassium hexafluoroarsenate	HEXAFLURATE
Potassium cyanate	KOCN
Pramex	ANTIRESISTANT/DDT
Pramitol®	PROMETONE
Prebane	IGRAN 80W®
Prefar®	BENSULIDE
PREFORAN®	
Premerge®	DINOSEB
Prep	SODIUM CIS-3-CHLOROACRYLATE
Primatol A®	ATRAZINE
Primatol P®	PROPAZINE
Primatol Q®	PROMETRYNE
Primatol S®	SIMAZINE

Name	Refer To
Primicid	PIRIMIPHOS ETHYL
Princep®	SIMAZINE
Prolan®	DILAN®
Prolate	IMIDAN®
PROMECARB	
PROMETONE	
PROMETRYNE	
PROPACHLOR	
Propanearsonic acid, calcium salt	CALCIUM PROPYLARSONATE
PROPANIL	
PROPARGITE	
PROPARGYL BROMIDE	
PROPAZINE	
2-Propenal	ACROLEIN
2-PROPENE-1,1-DIOL DIACETATE	
2-Propen-1-ol	ALLYL ALCOHOL
2-Propenylacrylic acid	SORBIC ACID
PROPHAM	
PROPHOS	
PROPIONIC ACID	
Propoxur	BAYGON®
S-Propyl butylethylthiocarbamate	PEBULATE
S-Propyl dipropylthiocarbamate	VERNOLATE
PROPYLENE OXIDE	
PROPYL ISOME	
Protect®	1,8-NAPHTHALIC ANHYDRIDE
Protex	ROTENONE
PROTHOATE	
Prussic acid	HYDROGEN CYANIDE
Puratized® agricultural spray	PAS
Pyramin®	PYRAZON
PYRAZON	
PYRETHRINS	

Name	Refer To
Pyrethrum	PYRETHRINS
PRYNACHLOR	
Queletox®	FENTHION
8-QUINOLINOL	
Quinomethionate	MORESTAN®
Quinophenol	8-QUINOLINOL
2,3-Quinoxalinedithiol cyclic trithiocarbonate	ERADEX
R-2063	CYCLOATE
R-4461	BENSULIDE
R-4572	MOLINATE
Rabon®	GARDONA®
Rack Granular®	ATRAZINE
Radapon®	DALAPON
Rad-E-Cate 35®	CACODYLIC ACID
Ramrod®	PROPACHLOR
Randox®	CDAA
Randox-T	TCBC
Raticate®	NORBORMIDE
RCl 49-155	ORTHOPHENYLPHENOL
RCl 49-162	PCP
RED SQUILL	
Regim-8®	TIBA
Reglone®	DIQUAT®
Resitox®	COUMAPHOS
Retard®	MH
Rhothane®	DDD
Rogor®	DIMETHOATE
Rogue®	PROPANIL
Ro-neet®	CYCLOATE
RONNEL	
Rootone®	NAPHTHALENE ACETAMIDE
ROTENONE	
Royaltac®	n-DECANOL
Ruelene®	CRUFOMATE

Name	Refer To
Rylanexcel®	RYANIA
RYANIA	
Ryanicide®	RYANIA
Ryanodine	RYANIA
S-4084	CYANOPHOS
S-4087	O-*p*-CYANOPHENYL O-ETHYL PHENYLPHOSPHONOTHIOATE
SABADILLA	SUCCINIC ACID DIMETHYLHYDRAZIDE
SADH	
Salithion®	2-METHOXY-4H-1,3,2-BENZODIOXAPHOSPHORIN-2-SULFIDE
Sarolix®	DIAZINON®
SBP-1382	
Schoenocaulon	SABADILLA
SCHRADAN	
SD3562	BIDRIN®
SD9098	AKTON®
SD9129	AZODRIN®
Seedrin	ALDRIN
Semasan®	HYDROXYMERCURICHLOROPHENOL
SEMESAN BEL®	
SES®	SESONE
SESONE	
Sevin®	CARBARYL
Shed-A-Leaf "L"	SODIUM CHLORATE
Shoxin®	NORBORMIDE
Sinbar	TERBACIL
SIDURON	
Silica aerogel	SILICA GEL
SILICA GEL	
Silicon dioxide, treated	SILICA GEL
SILVEX	
Silvex:	
butoxyethyl ester of	Silvex
butoxypolypropoxypropyl ester of	↓

Name	Refer To
Silvex (continued)	Silvex
butoxypropyl ester of	
diethanolamine salt of	
diisopropanolamine salt of	
dipropylene glycol isobutyl ether ester of	
ethanolamine salt of	
2-ethylhexyl ester of	
isooctyl ester of	
isopropanolamine salt of	
monohydroxyaluminum salt of	
potassium salt of	
propylene glycol butyl ether ester of	
propylene glycol isobutyl ether ester of	
sodium salt of	
triethanolamine salt of	
triethylamine salt of	
triisopropanolamine salt of	↓
tripropylene glycol isobutyl ether ester of	
SIMAZINE	
Sinbar®	TERBACIL
Sinox	DINOSEB
Slo-Gro®	MH®
SMDC	METHAM
Snip® Fly Bands	DIMETILAN
SODIUM ARSENATE	
SODIUM ARSENITE	
SODIUM CHLORATE	
SODIUM cis-3-CHLOROACRYLATE	
SODIUM 5-CHLORO-2-[4-CHLORO-2-[3-(3,4-DICHLOROPHENYL)UREIDO]PHENOXY]BENZENESULFONATE	
Sodium 2,4-dichlorophenoxyacetate	2,4-D
Sodium 2-(2,4-dichlorophenoxy)ethyl sulfate and sodium salt	SESONE
Sodium ethyl mercurithiosalicylate	ELCIDE® 73

Name	Refer To
Sodium Fluoaluminate	CRYOLITE
SODIUM FLUORIDE	
SODIUM FLUOROACETATE	
SODIUM FLUOSILICATE	
SODIUM ISOPROPYL XANTHATE	
Sodium metaarsenate	SODIUM ARSENATE
SODIUM METABORATE	
Sodium metaborate decahydrate	SODIUM METABORATE
Sodium metaborate tetrahydrate	SODIUM METABORATE
Sodium methyldithiocarbamate	METHAM
Sodium-*o*-phenylphenate	ORTHOPHENYLPHENOL
Sodium salt of N-(3,4-dichlorophenyl)-N'-2(2-sulfo-4-chlorophenoxy)-5-chlorophenyl urea	SODIUM 5-CHLORO-2-[4-CHLORO-2-[3-(3,4-DICHLOROPHENYL)UREIDO]-PHENOXY]BENZENESULFONATE
Sodium silicofluoride	SODIUM FLUOSILICATE
Sodium tetraborate decahydrate	BORAX®
Soilbrom-85®	EDB
SOK®	
SOLAN®	
SORBIC ACID	
Spectracide®	DIAZINON®
Spergon	CHLORANIL
Spotrete®	THIRAM
Stabilene®	BUTOXYPOLYPROPYLENE GLYCOL
Stam F-34	PROPANIL
Stathion®	ETHOXYQUIN
Stop-Scald®	ETHOXYQUIN
STREPTOMYCIN	
STROBANE®	
STRYCHNINE	
Strychnos nux-vomica alkaloids	STRYCHNINE
SUCCINIC ACID DIMETHYLHYDRAZIDE	
Sucker Plucker®	n-OCTANOL and n-DECANOL
Sucker-Stuff®	MH®

Name	Refer To
Sulfotepp	TETRAETHYL DITHIOPYROPHOSPHATE
Sulfox-Cide®	SULFOXIDE
SULFOXIDE	
SULFUR	
SULFURYL FLUORIDE	
SULPHENONE	
Sumithion®	FENITROTHION
Super X	TERRAZOLE®
Supracide®	METHIDATHION
Surcopur®	PROPANIL
Surecide®	O-*p*-CYANOPHENYL O-ETHYL PHENYLPHOSPHONOTHIOATE
Sutan®	BUTYLATE
SWEP	
Synklor®	CHLORDANE
Systox®	DEMETON
2,4,5-T	
Tabatrex	TABUTREX®
TABUTREX®	
Tandex®	KARBUTILATE
Tartar emetic	ANTIMONY POTASSIUM TARTARATE
2,3,6 TBA	
TBP	
TBTO	BIS(TRIBUTYLTIN)OXIDE
TCA	
TCBC	
TCNB	TETRACHLORONITROBENZENE
TCTP	
TDE	DDD
Tecrazene	TETRACHLORONITROBENZENE
Tedion®	TETRADIFON
TELODRIN	
Telone	D-D®
Telvar®	MONURON
Temik®	ALDICARB

Name	Refer To
Tenoran®	CHLOROXURON
TEPP	
TERBACIL	
TERBUTOL	
Terpene polychlorinates	STROBANE®
Terraclor®	PCNB
Terracur P®	FENSULFOTHION
TERRAZOLE®	
Tersan®	THIRAM
2-(p-Tertiary-butyl phenoxy)isopropyl-2-chloroethyl sulfite	ARAMITE
Tetrachloro-p-benzoquinone	CHLORANIL
2,4,5,4-Tetrachlorodiphenyl sulfone	TETRADIFON
Tetrachloroethene	TETRACHLOROETHYLENE
TETRACHLOROETHYLENE	
N-(1,1,2,2-Tetrachloro-ethylsulfenyl)-cis-4-cyclohexene-1,2-dicarboximide	DIFOLATAN®
Cis-N-[1,1,2,2-Tetrachloroethyl)-thiol]-4-cyclohexene-1,2-dicarboximide	DIFOLATAN®
2,4,5,6-Tetrachloroisophthalonitrile	CHLOROTHALONIL
TETRACHLORONITROBENZENE	
2,3,4,6-TETRACHLOROPHENOL	
Tetrachlorothiophene	TCTP
TETRADIFON	
TETRAETHYL DITHIOPYROPHOSPHATE	
0,0,0',0'-Tetraethyl S,S'-methylene bisphosphorodithioate	ETHION
Tetraethyl pyrophosphate	TEPP
Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione	DAZOMET
TETRAMETHRIN	
Tetramethyl phosphorodiamidic fluoride	DIMEFOX
0,0,0',0'-Tetramethyl 0,0'-thiodi-p-phenylene phosphorothioate	ABATE®

Name	Refer To
0,0,0',0'-Tetrapropyl dithiopyrophosphate	ASPON®
Tetron®	TEPP
Tetrasul	p-CHLOROPHENYL-2,4,5-TRICHLOROPHENYL SULFIDE
TFM	3-TRIFLUOROMETHYL-4-NITROPHENOL
THALLIUM SULFATE	
THANITE®	
THIABENDAZOLE	
2-(4-Thiazolyl)benzimidazole	THIABENDAZOLE
Thimerosal®	ELCIDE® 73
Thimet®	PHORATE
2-THIOCYANATOETHYL LAURATE	
β-Thiocyanoethyl laurate	2-THIOCYANATOETHYL LAURATE
2-Thiocycanoethyl laurate (or dodecanoate)	2-THIOCYANATOETHYL LAURATE
Thiodan®	ENDOSULFAN
Thiodemeton	DISULFOTON
Thiodiphenylamine	PHENOTHIAZINE
Thionazin	ZINOPHOS®
Thiophal	FOLPET
THIOPHANATE®	
THIOPHANATE METHYL®	
Thiophos®	PARATHION
Thioquinox	ERADEX®
THIRAM	
Thitrol®	MCPB
Thuricide®	BACILLUS THURINGIENSIS
Thylate®	THIRAM
TIBA	
Tiguvon®	FENTHION
Tillam®	PEBULATE
TMTD or TMTDS	THIRAM
TOK E-25	NITROFEN
m-TOLYL-N-METHYLCARBAMATE	
Topane®	ORTHOPHENYLPHENOL

Name	Refer To
Topsin®	THIOPHANATE®
Tordon®	PICLORAM
Toxakil®	TOXAPHENE
TOXAPHENE	
2,4,5-TP	SILVEX
Treflan®	TRIFLURALIN
TRIALLATE	
TRIARIMOL	
Triazine®	DYRENE®
Tri-ban	PIVAL®
Tributyl 2,4-dichlorobenzylphosphonium chloride	PHOSFON®
S,S,S-Tributyl phosphorotrithioate	DEF®
S,S,S-Tributyl phosphorotrithioite	FOLEX®
Tributylin oxide	BIS(TRI-n-BUTYLTIN)OXIDE
TRICAMBA	
Trichloracetic acid	TCA
TRICHLORFON	
S-2,3,4-Trichloroallyl diisopropylthiolcarbamate	TRIALLATE
3,5,6-Trichloro-o-anisic acid	TRICAMBA
Trichlorobenzylchloride	TCBC
Trichlorobenzoic acid	2,3,6 TBA
4,5,7-TRICHLOROBENZTHIADIAZOLE-2,1,3	
2,3,6-Trichlorobenzyloxypropanol	TBP
1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane	DDT
1,1,1-TRICHLOROETHANE	
N-Trichloromethylthio-4-cyclohexane 1,2-dicarboximide	CAPTAN
N-(Trichloromethylthio)-phthalimide	FOLPET
Trichloronitromethane	CHLOROPICRIN
2,4,5-TRICHLOROPHENOL	
2,4,6-TRICHLOROPHENOL	

Name	Refer To
2-(2,4,5-Trichlorophenoxy)ethyl-2,2-dichloropropionate	ERBON
2-(2,4,5-Trichlorophenoxy)-propionic acid	SILVEX
2,4,5-Trichlorophenoxyacetic acid	2,4,5-T
alkyl (C3H7 - C7H9) ester of	
alkyl (C-12)amine salt of	
alkyl (C-13)amine salt of	
alkyl (C-14)amine salt of	
amyl ester of	
butoxyethyl ester of	
butoxypropyl ester of	
butyl ester of	
diethylethanolamine salt of	
dimethylamine salt of	
N,N-dimethyloleylamine salt of	
dipropylene glycol isobutyl ether ester of	
2-ethylhexyl ester of	
isobutyl ester of	
isopropyl ester of	
N-oleyl-1,3-propylenediamine salt of	
propylene glycol butyl ether ester of	
propylene glycol isobutyl ether ester of	
sodium salt of	
triethanolamine salt of	
triethylamine salt of	
tripropylene glycol isobutyl ether ester of	
2,3,6-Trichlorophenylacetic acid or sodium salt	FENAC®
2,4,5-Trichlorophenylazo-4-chlorophenyl sulfide	[(p-CHLOROPHENYL)THIO] (2,3,5-TRICHLOROPHENYL) DIIMIDE
TRIDEMORPH	

Name	Refer To
Tridex	EXD
TRIETAZINE	
Tri-Fene®	FENAC®
Trifenson®	FENSON®
α,α,α-Trifluoro-2,6-dinitro-N,N-dipropyl-*p*-toluidine	TRIFLURALIN
3-TRIFLUOROMETHYL-4-NITROPHENYL	
TRIFLURALIN	
2,3,5-Triodobenzoic acid	TIBA
TRIMEDLURE	
2,3,5-Trimethylphenyl N-methylcarbamate	LANDRIN
3,4,5-Trimethylphenyl N-methylcarbamate	LANDRIN
Triphenyltin acetate	FENTIN ACETATE
TRIPHENYLTIN HYDROXIDE	
Tris[(2,4-dichlorophenoxy)ethyl] phosphite	2,4-DEP
Tris[(2-hydroxyethyl)(phenylmercuric)ammonium]lactate	PAS
Tritac®	TBP
Trithion®	CARBOPHENOTHION
Trolene®	RONNEL
Trona	BORAX
Tronabor®	BORAX
TROPITAL®	
Tropotox®	MCPP
Trysben	2,3,6 TBA
Tumbleaf®	SODIUM CHLORATE
Tumex®	8-QUINOLINOL
Tupersan®	SIDURON
Tutane®	2-AMINOBUTANE
UC21149	ALDICARB
Unden®	BAYGON®
Urab®	FENURON TCA
Ureabor®	2,3,6 TBA
Urginea maritima extract	RED SQUILL
Urox®	MONURON TCA
Vancide FE-95®	FERBAM
Vancide MZ-96®	ZIRAM
Vancide 20-S®	GLYODIN®
Vancide TM-95®	THIRAM
Vapam®	METHAM
Vapatone®	TEPP
Vapona®	DICHLORVOS
V-C-9-104	PROPHOS
V-C-13	NEMACIDE
Vegadex®	CDEC
Venzar®	LENACIL
Veratrine	SEBADILLA
Verbigen	CHLORAMBEN
Vernam®	VERNOLATE
VERNOLATE	
Verton® D	2,4-D
Vidden D	D-D®
Vikane®	SULFURYL FLUORIDE
Viozene®	RONNEL
Vitavax	CARBOXIN
VORLEX®	
Vorlex 201	VORLEX®
VPM	METHAM
WARFARIN	
Weedar®	2,4,-D
Weedazol®	AMITROLE
Weed-E-Rad®	DSMA
3,4-XYLYL N-METHYLCARBAMATE	
Yomesan	BAYLUSCIDE®
Zectran®	4-DIMETHYLAMINO-3,5-XYLYL N-METHYLCARBAMATE
Zerlate®	ZIRAM

Name	Refer To	Name	Refer To
Zinc and manganese ethylene bisdithiocarbamate, coordination product of	DITHANE M-45®		
Zinc dimethyl dithiocarbamate	ZIRAM		
Zinc ethylene bisdithiocarbamate	ZINEB		
ZINC PHOSPHIDE			
ZINEB			
ZINOPHOS®			
ZIP®	ZIRAM		
ZIRAM			
ZOALENE			
Zobar®	PBA		
6-12®	ETHYL HEXANEDIOL		
1080	SODIUM FLUOROACETATE		

SECTION XI

REFERENCE CHARTS OF PESTICIDE PROPERTIES PERTINENT TO DISPOSAL

Data on the physical properties and other properties pertinent to the disposal of pesticides have been collected from the literature and from manufacturer's technical data sheets, bulletins or booklets, and are tabulated here for 550 pesticides. The chart headings are discussed and some specific sources of data are indicated below. Symbols and abbreviations used are given in Table 10.

Common name: The arrangement is in alphabetical order according to a common name of the "primary entry" name which has been adopted herein. The method of cross-indexing pesticide names to the primary entry name and the rules followed in alphabetizing names are given in Section X. The reader should turn to the cross-index if a pesticide name cannot be found in these charts.

Chemical name: Consistent chemical nomenclature has yet to be adopted for all pesticides by the manufacturers, the scientific community, and the regulatory governmental agencies. Chemical Abstracts nomenclature has been preferred herein where available,[1-9] but Chemical Abstracts were not checked for current usage. Several other sources of chemical names have been utilized.[5,6,8,11,67,68]

Structural formula: Chemical structures were adapted from the literature[1,5,6,8,11,67] and are generally standard.

Description: The type of pesticide and the formulations marketed, as well as the physical form, melting point and boiling point, are given for each compound. The data generally refer to the pure active ingredient (unless technical material is indicated), but sample purity is usually unstated in the literature. Temperatures are in centigrade, °C. Pressures refer to millimeters of mercury.

Solubility: The relative or actual solubilities of the pesticides in water, a hydrocarbon such as kerosene, one of the lower alcohols, and other common organic solvents are indicated. Metric units are used unless otherwise indicated, and data refer to approximately 20 to 25°C unless indicated. Data may be for the technical product in many cases. Additional data may be available for some pesticides in the chemical literature or from the manufacturers.

Stability: The stabilities to heat, light, moisture or other agents are indicated. Decomposition temperatures are in °C. The data may be for the technical products in many cases. Additional data may be available for some pesticides in the chemical literature or from the manufacturers.

TABLE 10

SYMBOLS AND ABBREVIATIONS FOR REFERENCE CHARTS

Use

A - attractant
F - fungicide
Fu - fumigant
H - herbicide
I - insecticide
L - larvacide
La - lampreycide
M - miticide
Mo - molluscicide
N - nematocide
NI - nitrification inhibitor
R - repellent
Ro - rodenticide
Syn - synergist
PGR - plant growth regulator
PH - protectant against herbicides

Formulation

a - aerosol
aq - aqueous
b - bait
c - concentrate
cg - compressed gas
d - dust
ec - emulsifiable concentrate
fm - fertilizer mixture
g - granuals
ℓ - liquid (not otherwise defined)
os - oil solution
p - powder
pl - pellets
s - spray
ulv - ultralow volume
wml - water miscible liquid
wsc - water soluble concentrate

Physical Form

G - gas
L - liquid
S - solid
sub - sublimes
mm - millimeters mercury
o - oil
w - waxy solid
v - viscous liquid

Solubility

s. - soluble
ins - insoluble
sl.s. - slightly soluble
m.s. - moderately soluble
v.s. - very soluble
mis - miscible
g/ℓ - grams per liter
ppm - parts per million
% w/w - percent by weight
ace - acetone
bz - benzene
xyl - xylene
dsl - diesel oil
pet - petroleum oils
ker - kerosene
org - organic solvents
Et - ethanol
Me - methanol
i-Pr - 2-propanol

Stability

st - stable
dec - decomposed
hyd - hydrolyzed
acd - acid
alk - alkali (bases)
uv - ultraviolet
de-HCl - dehydrochlorinated

Toxicity

LD_{50} - lethal dose, to 50% of test animals, in mg pesticide per kg body weight.
LD_{50}'s are for rats unless otherwise specified:
m (mice), Rb (rabbit),
mk (monkey), cat, dog.

high - highly toxic
low - low toxicity
skin - absorbed through skin

Environmental Comment

pp - permanently persistent
per - persistent
tox - toxic to fish or wildlife
n - nontoxic to fish or wildlife
v - very

oxicity: Toxicity data vary widely depending on the species and the train tested, the test conditions, and the purity of the test substance. cute oral and dermal LD_{50}'s in mg/kg are shown for rats except as indiated.

cute dermal LD_{50}'s are also given or in some cases the word "skin" is sed to indicate that the compound is toxic by contact. The data were selected primarily from three sources,[1,8,69] but several supplemental sources were used.[5,6,11,67,68,70] An evaluation of toxicity data is beyond the scope of this work. Toxicity data are grouped according to pesticide use classification for a number of compounds in Section VI.

Environmental Comment: The relative persistence in the environment and the toxicity to fish and wildlife are indicated where available.[13,67,71,72] A brief discussion of persistence and additional environmental hazard data are given in Section VI. The absence of a comment does not mean that the pesticide is necessarily without environmental hazard or that further information is not available in the specialized literature.

Disposal procedure: Potential disposal procedures described in Section XII are indicated for each compound. Additional information on the detoxification and degradation chemistry of the class of compounds of which this pesticide is a member is given starting on the page indicated.

Several guidelines were used in selecting the preferred and alternate disposal procedures for each pesticide. Primary considerations were the toxicity of the substance and the availability of suitable chemical methods for its degradation. Other properties, such as its environmental persistence, volatility, flammability and chemical composition were also considered. These secondary considerations were applied collectively rather than in a sequential order and the trade-off evaluations included a consideration of the safety of reported detoxification procedures. Special consideration was given in a few cases to other properties of the chemical or its formulations, e.g., a substance already present in the environment or a pesticide marketed only as a diluted formulation. The guidelines are summarized in Table 11.

TABLE 11

GUIDELINES USED IN SELECTING DISPOSAL PROCEDURES FOR THE LAYMAN

Characteristic	Criteria	Procedures Considered		Procedures Excluded
		Preferred	Alternate	
Toxicity	Oral LD_{50}			
	< 10	1,2	None	3-14
	10-200	1-3	5-14[a]	4
	200-2,000	1-3, 5-14[a]	5-14	4
	> 2,000	1-14[a]	4-14[a]	--
Persistence	Chemical Class			
	Organochlorine compounds (if persistent)	5	1-3	4,6,11,12,13
	Mercury, lead, cadmium, arsenic and certain other heavy metals	1-3,11	1-3	4,6,12,13
Chemical Composition	Type			
	Phosphorus-containing	1-3, 5,7	--	--
	Nitrogen-containing	1-3, 5,7	7	
	Highly chlorinated	5	1-3	6
	High levels of nitrogen or sulfur	5, 7-14[a]	5, 7-14[a]	6
	Simple organics	11-14[a]	11-14[a]	--
Volatility	Nature			
	Flammable hydrocarbon liquid	1-3	4,14	--
	Flammable hydrocarbon compressed gas	1-3	14	4,6
	Chlorinated hydrocarbon liquid	1-5	12,14	6
	Chlorinated hydrocarbon compressed gas	5,14	1-3	6

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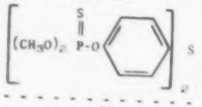
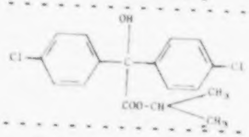
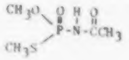
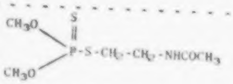
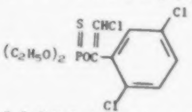
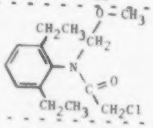
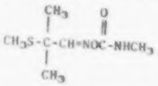
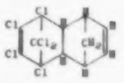
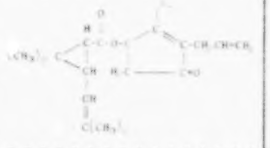
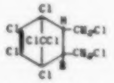
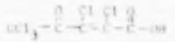
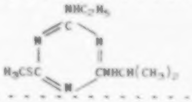
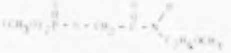
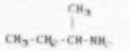
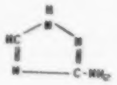
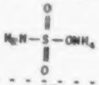
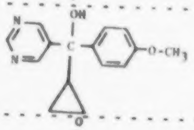
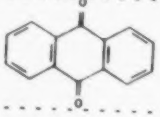
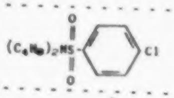
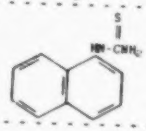
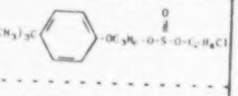
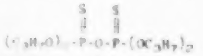
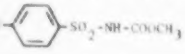
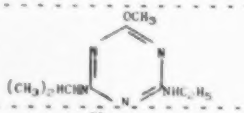
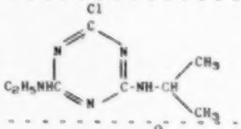
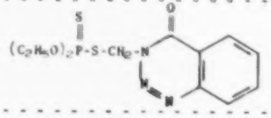
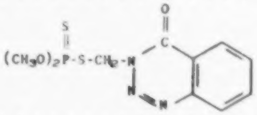
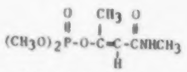
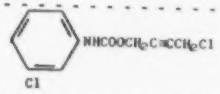
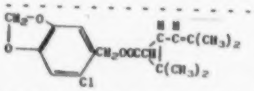
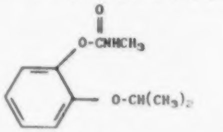
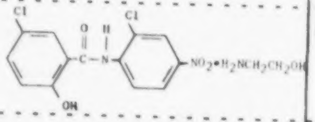
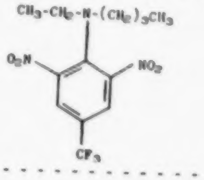
[a] As applicable.

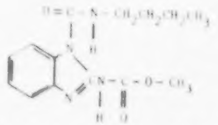
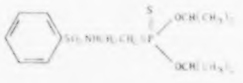
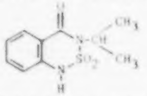
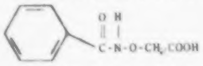
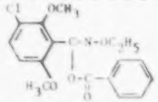
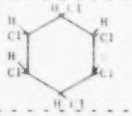
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Abate® 0,0,0',0'-Tetramethyl 0,0'-thiodi-p-phenylene-phosphorothioate		L I	ec g	S or L	30		ins.	s.							2,330					1-3	7	67
Acaralate® Isopropyl 4,4'-dichloro-benzilate		M	ec	S	74		10	s.							5,000					1-4	11	105
Acephate 0,S-Dimethyl acetylphos-phoramidothioate		I	p	S	72- 80 °C		65%	<5%	>10%						900	Rb 2,000				7	1-3	74
S-(2-Acetamidoethyl)0,0-di-methylphosphorodithioate		I													m 438	m 472				1-3	7	71
Acetic Acid	CH_3COO_H	F	ℓ	L	16.6	118.5	mis		mis		st	st	st	3310 mg/kg		n				13	11 12	128
Acrolein Propenal	$CH_2{=}CHCHO$	H M	wsc a	L	-87	53	m.s.	mis	mis						46	Rb 562				1-3	10	128
Acrylonitrile	$CH_2{=}CHC{\equiv}N$	Fu		L	-82	77	7.5% w/w	mis							93					1-3	12	98
Akton® O-[2-Chloro-1(2,5-dichloro-phenyl)vinyl]0,0-diethyl-phosphorothioate		I	ec g	L	26	145 .005 mm	1.39 ppm	50%							146	Rb 177				1-3	7	67
Alachlor® 2-Chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide		H	ec	S	40		148 ppm	s.	s.		dec 105°C				1,800					5	1-3	83
Aldicarb 2-Methyl-2-(methylthio)pro-pionaldehyde O-(methyl-carbamoyl)oxime	 $CH_3S\text{-}\overset{CH_3}{\underset{CH_3}{C}}\text{-}CH{=}NO\overset{O}{C}\text{-}NHCH_3$	I		S	100		0.6%	ker 0.5%	Et 25%	org s.			dec con alk		.93					1-3	--	76

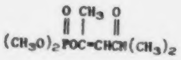
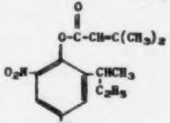
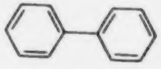
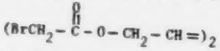
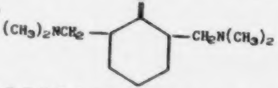
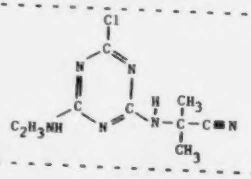
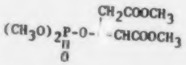
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Aldrin 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4,-exo-5,8-dimethano-naphthalene		I	wp ec s l g	S	104		<0.1 ppm	ker 28g/ 100 ml	xyl 235g/ 100 ml					dec con acd	67	Rb >200	per			1-3	5	109
Allethrin DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one, esterified with a mixture of cis- and trans-DL-chrysanthemum monocarboxylic acid		I	a	L		160	ins.	s.	s.						2,330					11	6	125
Allyl alcohol 2-Propen-1-ol	$CH_2=CHCH_2OH$	H	os l	L	-129	97	mis.		org s.						64	Rb 89	n	tox	tox	1-3	12	128
Alodan 1,2,3,4,7,7-Hexachloro-5,6-bis(chloromethyl)-2-norbornene		I		S	105	174 2mm	i	s.							m 10,000					1-3	--	109
Alorac (Z)-2,3,5,5,5-Pentachloro-4-oxo-2-pentenoic acid	 $CCl_3-\overset{O}{\overset{\|}{C}}-\overset{Cl}{\overset{\|}{C}}=\overset{Cl}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-OH$	H		S	85	137 2.5 mm	6g/1		ace xyl s.											1-3	5	112
Aluminum phosphide	AlP	Fu	pl	S	>1,000		dec						dec	dec acd	Haz. 1 ppm air					1-3	11	60
Ametryne 2-(Ethylamino)-4-isopropylamino-6-(methylthio)-s-triazine		H	wp	S	85		185 ppm								1,110					1-3 5	6,7	89
Amidithion S-[(2-Methoxyethyl)carbamoylmethyl]O,O-dimethyl-phosphorodithioate	 $(CH_3O)_2\overset{S}{\overset{\|}{P}}-S-CH_2-\overset{O}{\overset{\|}{C}}-N{<}^{H}_{C_2H_4OCH_3}$	I M		S	36		2%		org s.					hyd by alk						1-3	7	71
2-Aminobutane (disposal information applies to aminobutane carbonate also)	 $CH_3-CH_2-\overset{CH_3}{\overset{\|}{CH}}-NH_2$	F		L	-104	63	mis	sl.s.	org mis						380					1-3	5,11	99

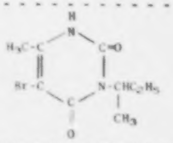
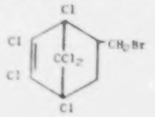
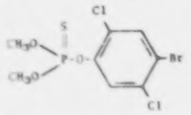
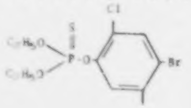
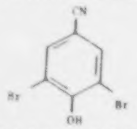
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Amitrole 3-Amino-1,2,4-triazole		H	wsc sp	S	154		28g/ 100g	ins.	Et	ace	st				24,000			1,470 ppm safe for fish		11	12,13	91
AMS **Ammonium sulfamate**	 $H_2N-\overset{O}{\underset{O}{\overset{\Vert}{\underset{\Vert}{S}}}}-ONH_4$	H	p	S	130 dec		68g/ 100g		sl.s.		dec 160°				3,900		6 mo			11	12,13	62
Ancymidol α-Cyclopropyl-α-(p-methoxyphenyl)-5-pyrimidinemethanol		PGR	wml	S	109.5- 111°C		0.5mg/ ml	s.s	v.s.		st to 200 °C		st	dec pH <4.0	4,500 mg/kg	>200 Rb				11	4 6	91
Anthraquinone 9,10-Anthraquinone		R	wp	S	285 sub	377	ins		sl.s.	bz sl.s	sub				5,000			low		11	6,12	130
Antimony potassium tartrate **Potassium antimonyl tartrate**	$K(SbO)C_4H_4O_6 \cdot 1/2H_2O$	I	b s.	S			8.5g/ 100 ml		i		-1/2 H_2O 100°				lethal to human 130mg			v tox		1-3	11	59
Antiresistant/DDT N,N-Di-n-butyl-p-chlorobenzene-sulfonamide		Syn	ec	S	37										4,000					1-3	5	122
ANTU® α-Naphthylthiourea		Ro	b c	S	198		.06g/ 100 ml		ace 2.3 g/ 100 ml						6-8 mk, 4,250					6	11	99
Aramite® 2-(p-tert-Butylphenoxy)-1-methylethyl-2'-chloroethyl sulfite		M	d wp ec	L	-32	175 0.1 mm	m.s	e.	org		dec		hyd alk		3,900					7	12	122
Arsenic acid	$H_3AsO_4 \cdot 1/2\ H_2O$	H		S	36		16.7g/ 100 ml	s.			$-H_2O$ 160				100		PP			11	1-3	56

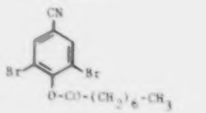
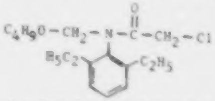
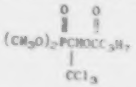
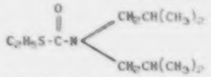
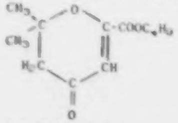
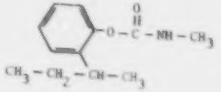
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Arsenic trioxide	As_2O_3	R	3% aq	S	313	sub	3.7g/ 100 ml		ins.						13			pp in soil		11	1-3	56
Aspon® O,O,O',O'-Tetra-n-propyldithiopyrophosphate	 $(C_3H_7O)_2\overset{S}{\overset{\|}{P}}-O-\overset{S}{\overset{\|}{P}}-(OC_3H_7)_2$	M I	g c ec	L	~5	104 .01 mm					dec 149 °C				1,000					1-3	5	67
Asulam Methyl sulfanilylcarbamate		H	l	S	135 °C		0.5%	<2%	28%		st	st	st		>5,000 mg/kg	>1,200 mg/kg				11	13	76
Atratrone 2-Ethylamino-4-isopropylamino-6-methoxy-s-triazine		H		S	95		0.18 g/100 ml								2,400					1-4	6,7	89
Atrazine 2-Chloro-4-(ethylamino)-6-isopropylamino-s-triazine		H	wp g l	S	174		33 ppm		1.0g/ 100 ml			dec uv			3,030					1-5	6,7	89
Azinphosethyl O,O-Diethyl S-(4-oxo-1,2,3-benzotriazin-3[4H]ylmethyl) phosphorodithioate		I	ec wp d	S	53	111 .001 mm	ins.			org				hyd alk	17.5					1-3	7	71
Azinphosmethyl O,O-Dimethyl S-(4-oxo-1,2,3-benzotriazin-3[4H]ylmethyl) phosphorodithioate		I	ec wp ulv	w	73		ins.			org s.	dec above 200			hyd acd alk	16.4	220				1-3	7	71
Azobenzene Diphenyl diimide	$C_6H_5N{=}N{-}C_6H_5$	M Fu	wp sc lc d	S	68	293	ins.	s.		org s.					>1,000					1-3	4	99

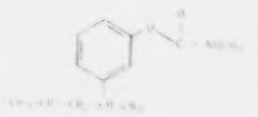
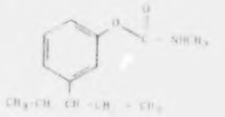
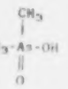
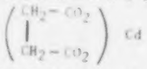
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Azodrin® Dimethyl phosphate of 3-hydroxy-N-methyl-cis-crotonamide	 $(CH_3O)_2\overset{O}{\overset{\|}{P}}-O-\overset{CH_3}{\overset{\mid}{C}}=\underset{H}{C}-\overset{O}{\overset{\|}{C}}NHCH_3$	I	wml l	S	54	125	mis		Et s.	ace s.				hyd alk	21	Rb 354			tox ducks geese	1-3	7	65
Bacillus thuringiensis	N.A.	I	wp d sc b								dec	dec				None				13	11	125
Bandane® Polychlorobicyclopentadiene isomers (60-62% chlorine)	mixture	H I	ec d g	v w	49		ins.		v.s.		most org v.s.				575					5	1-3	109
Barban 4-Chloro-2-butynyl m-chlorocarbanilate		H	ec	S	76		1.1 mg/ 100g	ker .5g/ 100g		bz 37.0 g/ 100g	dec 75°C				1,350					1-4	11	76
Barthrin 6-Chloropiperonyl chrysanthemumate		I	os a	L		163 .5 mm	ins.	ker s.		ace s.					23ml low					11	6,12	125
Baygon® 2-Isopropoxyphenyl N-methylcarbamate		I	ec wp d g c	S	91		0.1%		s.	ace s.				alk dec	100	< 200				1-3	7	76
Bayluscide® 2-Aminoethanol salt of 2',5-dichooro-4'-nitrosalicylanilide		Mo	wp g	S	216		230 ppm								10,000					11	13	95
Benefin N-Butyl-N-ethyl-α,α,α,-trifluoro-2,6-dinitro-p-toluidine		H	g c ec	S	66	149 7mm	70 ppm			ace xyl v.s.	dec uv				10,000					11	5	95

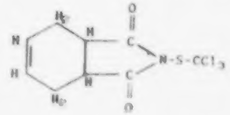
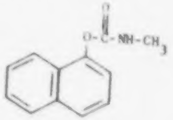
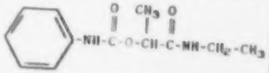
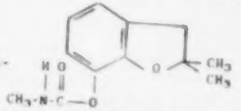
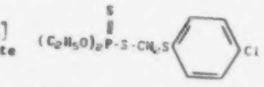
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Benomyl Methyl-1-(butylcarbamoyl)-2-benzimidazolecarbamate		F	wp	S	dec		ins.		Et 0.4g/ 100g	org sl.s.	dec				>9,590					11	6	76
Bensulide S-(O,O-Diisopropyl phosphorodithioate)ester of N-(2-mercaptoethyl)benzenesulfonamide		H	ec g	S	34		25 ppm	ker 0.3 g/l	mis	xyl mis					770					8	1-3 7	71
Bentazon 3-Isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide		H	g wp	S	137- 139°C		.05 g/g	3g/ g	86.1 g/g						1,100	>2,500				11	1-3	93
Benzadox Benzamidooxyacetic acid		H		S	140		1.6 g/100 ml	sl.s.	Me s.	ace s.					5,600					7	11	86
Benzene		Fu		L	5.5	80	sl.s.	s.	mis	org mis	s.		s.		5,700	skin				5	6	128
Benzomate Ethyl O-benzoyl-3-chloro-2,6-dimethoxybenzohydroximate		M	L wp	S											>15,000					11	12,13	99
Benzyl benzoate Benzoic acid, benzyl ester	$C_6H_5COOCH_2C_6C_5$	I		o w	20	324	ins.		s.						1,700					11	12	130
Benzyl thiocyanate	$C_6H_5CH_2SC{\equiv}N$	I		S	41		ins.		s.											5,6	11	123
BHC Mixed isomers of benzene hexachloride		I	ec wp d	S	~225		ins.			bz s.					125- 200		>12 mo	tox to fish	tox to honey bees	5	1-3	112

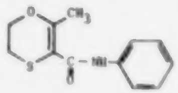
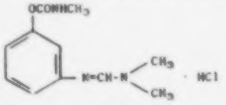
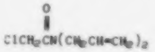
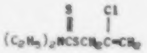
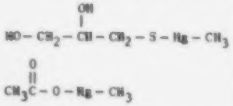
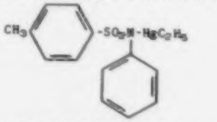
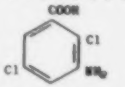
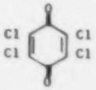
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Bidrin® Dimethylphosphate of 3-hydroxy-N,N-dimethyl-cis-crotonamide	 $(CH_3O)_2\overset{O}{\overset{\Vert}{P}}O\overset{CH_3}{\overset{\vert}{C}}{=}CH\overset{O}{\overset{\Vert}{C}}N(CH_3)_2$	I	ec wsc	L		400	mis	dsl ker <1% w/v		ace mis	dec				19	Rb 225				1-3	7	65
Binapacryl 2-sec-Butyl-4,6-dinitrophenyl-3-methyl-2-butenoate		M	ec wp d	S	68		ins.		Et 11%	org s.		dec uv	hyd	dec air acd	145					11	5	95
Biphenyl		F		S	70	256	ins.		s.	org s.					3,280					11	6 12	130
Bis-1,4-bromoacetoxy-2-butene	 $(BrCH_2-\overset{O}{\overset{\Vert}{C}}-O-CH_2-CH=)_2$	F																		5	11	115
2,6-Bis(dimethylaminomethyl)-cyclohexanone		I F N		L																5	1-3 6	99
Bis-tri-n-butyltin oxide	$(C_4H_9)_3Sn-O-Sn(C_4H_9)_3$	F		L		180 2mm	ins.			org mis					200					1-3	11	59
Bladex® 2-(4-Chloro-6-ethylamino-s-triazine-2-ylamino)-2-methylpropionitrile		H	g wp	S	167		71 ppm		Et 4.5% w/v	ace 19.5% w/v bz 1.5% w/v					149 to 334	Rb >2,000				1-3	5,7	89
Bowyl® Dimethyl 3-hydroxyglutaconate dimethyl phosphate	 $(CH_3O)_2\underset{O}{\underset{\Vert}{P}}-O-\overset{CH_2COOCH_3}{\overset{\vert}{C}}{=}CHCOOCH_3$	I M	ec wp	L		164 2mm	ins.	ker ins.	Et s.	ace s. xyl s.			hyd alk		32					1-3	7	65

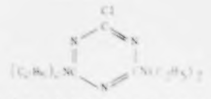
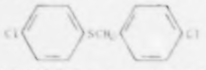
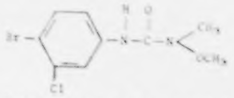
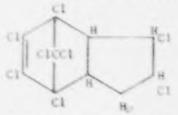
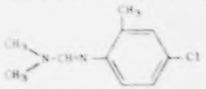
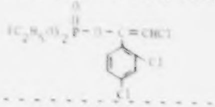
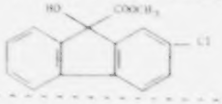
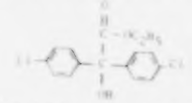
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Borax Sodium tetraborate decahydrate	$NaB_4O_7 \cdot 10H_2O$	H I	c g	S	~62	200	8 g/100g		ins.	ace .6g/100g	$-H_2O$ 60-320°	st	st		5,560					11	4 13	62
Bordeaux mixture Mixture of copper sulfate and calcium hydroxide	Approximately $CuSO_4 \cdot 3Ca(OH)_2 + CaSO_4$	F		S			ins.					st	st							11	1-3	58
Bromacil 5-Bromo-3-sec-butyl-6-methyluracil		H	wp p	S	158	sub	0.815 g/ℓ		Et 13.4 g/100ml	ace 16.7 g/100 ml	st			st alk dec acd slowly	5,200					5	6	87
Bromodan 5-(Bromomethyl)-1,2,3,4,7,7-hexachloro-2-norbornene		I		S	77		ins.								12,500					5	1-3	109
Bromophos O-(4-Bromo-2,5-dichlorophenyl)O,O-dimethyl phosphorothioate		I	ec wp d g	S	54		40 ppm			org s.					3,750					7	11	67
Bromophos-ethyl O-(4-Bromo-2,5-dichlorophenyl)O,O-diethyl phosphorothioate		I	ec wp d g	L		122	2 ppm			org mis					71-270					1-3	7	67
Bromoxynil 3,5-Dibromo-4-hydroxybenzonitrile		H	wsc s ec	S	190		<0.2%			ace s.					250					5	1-3 11	116

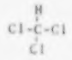
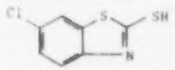
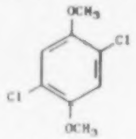
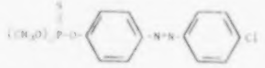
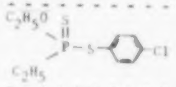
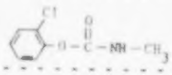
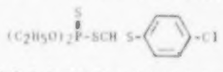
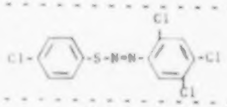
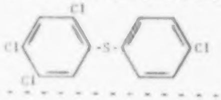
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Bromoxynil, octanoate 3,5-Dibromo-4-octanoyloxybenzonitrile		H	ec	S	190 °C		>.02 %	v.s.			st	st	st		250 mg/kg	2,000 mg/kg				11	12	116
Butachlor 2-Chloro-2',6'-diethyl-N-(butoxymethyl)acetanilide		H	ec g	c L			4 ppm								1,600	2,510 to 5,010 Rb				5	1-3	83
Butonate O,O-Dimethyl-2,2,2-trichloro-1-*n*-butyloxyethoxyethylphosphonate	 $(CH_3O)_2P(=O)CH(CCl_3)OC(=O)C_3H_7$	I		o		113 .03 mm				org mis	dec 150°				1,100					7	11	130
Butoxy polypropylene glycol	$C_4H_9[OCH(CH_3)CH_2]OC_4H_9$	R		L			sl.s.	mis		org mis					11,200					4 13	11 12	130
Butylate S-Ethyldiisobutylthiocarbamate		H	ec g	L		71 10mm	22 ppm	ker mis	mis	ace mis					4,659					5	6 11	79
Butyl mesityl oxide oxalate Butyl 3,4-dihydro-2,2-dimethyl-4-oxo-2H-pyran-6-carboxylate		R		L		~260	ins.sl.s.		mis						7,840					11	12,13	130
o-sec-Butylphenyl N-methylcarbamate		I			32										mice 410					7	1-3	76

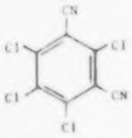
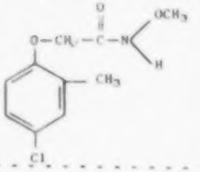
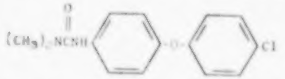
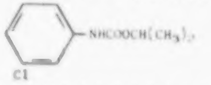
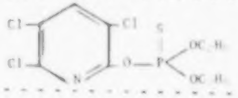
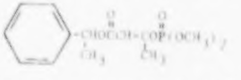
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
BUX TEN® 3:1 Mixture of m-(1-Methylbutyl)phenyl methylcarbamate and m-(1-ethylpropyl)-phenyl methylcarbamate	 	I	ec g	L S	26	~125 .04mm	50 ppm	s.	Me s.	xyl v.s.					1,050					7	1-3	76
Cacodylic acid Hydroxydimethylarsine oxide	 $CH_3-\underset{\underset{O}{\parallel}}{\overset{\overset{CH_3}{\vert}}{As}}-OH$	H	sp	S	200		66.7 g/100 ml		20g/ ml						830		PP			11	1-3	56
Cadmium-calcium-copper-zinc sulfate chromate complex	Undetermined structure	F															PP			11	1-3	58
Cadmium sūccinate	 $\left(\begin{array}{l}CH_2-CO_2\\ \vert\\ CH_2-CO_2\end{array}\right)Cd$	F					ins.			org ins.					660		PP			1-3	11	59
Calcium arsenate Basic calcium arsenate mixture	$3[Ca_3(AsO_4)_2]\cdot Ca(OH)_2$	I	wp d	S			ins.			acd s.					35-100					11	1-3	56
Calcium cyanamide	$CaCN_2$	F H	g	S	sub 1,300	1190 760 mm	dec						dec		1,400	1				9	11	60
Calcium cyanide	$Ca(CN)_2$	Fu	d g	S	dec >350		s.													9	11	60

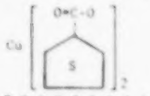
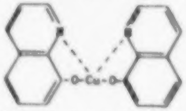
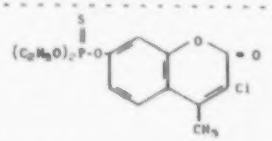
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Calcium propylarsonate	$CaC_3H_7AsO_3$	H	g																	11	1-3	56
Captan N-[(Trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide		F	wp d	S	158- 164	dec	3.3 ppm			xyl 6.5g/ 100ml			hyd		9,000- 10,000		n			7	11	85
Carbaryl 1-Naphthyl N-methylcarbamate		I	d g wp	S	142		40 ppm		s.	org s.	st uv				500	>2,000 Rb				7	1-3	76
Carbetamide D-N-Ethyllactamide carbanilate		H	ec wp	S	119		3.5 g/1	ins.	Me Et s.	ace s.					11,000					7	11	86
Carbofuran 2,3-Dihydro-2,2-dimethyl-7-benzofuran-yl N-methylcarbamate		I N	wp g	S			700 ppm			ace 15% w/w					8-14					1-3	7	76
Carbon disulfide	CS_2	Fu	ℓ	L	-109	46	.2g/ 100g	s.	mis								n			12	11 14	128
Carbon tetrachloride	CCl_4	Fu	ℓ	L	-23	76	.08g/ 100g	s.	s.	org mis					5,730		n			12	11 14	112
Carbophenothion S-[(p-Chlorophenylthio)methyl] O,O-diethylphosphorodithioate		I M	ec wp d g	L		82 .01 mm	<.04 g/1			org mis					32.2					1-3	7	71

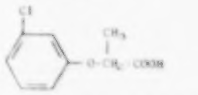
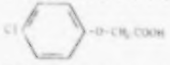
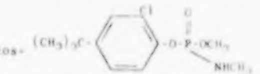
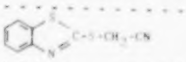
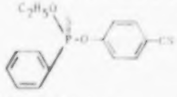
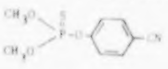
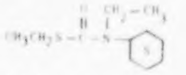
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Carboxin 5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide		F	wp g	S	92		170 ppm		Et 11% w/w Me 31% w/w	ace 60% w/w					3,200					5	6	80
Carzol® m-[[(Dimethylamino)-methylene]-amino]phenyl N-methylcarbamate hydrochloride		M I	sp	S			>50%		~25%		dec 200°				21					1-3	7	76
CDAA N,N-Diallyl-2-chloroacetamide	 $ClCH_2\overset{O}{\overset{\|}{C}}N(CH_2CH{=}CH_2)_2$	H	ec g	o		74 .3mm	2%	pet m.s.	Et s.	xyl s.					750					5	1-3	80
CDEC 2-Chloroallyl diethyldithiocarbamate	 $(C_2H_5)_2N\overset{S}{\overset{\|}{C}}SCH_2\overset{Cl}{\overset{\|}{C}}{=}CH_2$	H	g c	L		128 1mm	92 ppm	ker s.		ace bz s.					850	low		n		8	1-3	83
Ceresan L® Mixture of methylmercury 2,3-dihydroxy propyl mercaptide and methylmercury acetate	 $HO-CH_2-\overset{OH}{\overset{\|}{CH}}-CH_2-S-Hg-CH_3$ $CH_3\overset{O}{\overset{\|}{C}}-O-Hg-CH_3$	F	wsc	S	66		s.													1-3		. 54
Ceresan M® N-(Ethylmercury)p-toluene sulfonanilide		F	wp d c	S	156		ins.		Et sl.s.	ace s. bz sl.s.					100					1-3		54
Chloramben 3-Amino-2,5-dichlorobenzoic acid		H	g I	S	201		700 ppm		Et 17.3 g/100g	ace 23.3 g/100 g	st		st	st acd	3,500					5	1-3 11	116
Chloranil 2,3,5,6-Tetrachloro-1,4-benzoquinone		F	wp d	S	209	sub	250 ppm								4,000					5	1-3	119

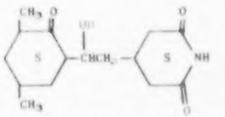
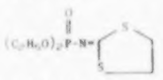
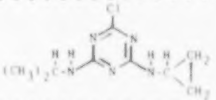
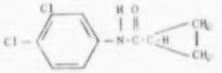
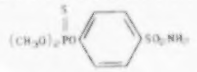
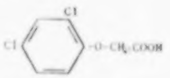
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Chlorazine 2-Chloro-4,6-bis(diethylamino)-s-triazine		H		L	16		9 ppm		Et s.	ace xyl s.					1,750					1-3	6,7	89
Chlorbenside p-Chlorobenzyl-chlorophenyl sulfide		M	wp ec	S	72	150 0.02 mm	ins.	pet sl.s.	low	ace s.					>10,000			n		11	5	121
Chlorbromuron 3-[4-Bromo-3-chlorophenyl]-1-methoxy-1-methylurea		H	wp g	S	95		20 ppm			ace s.					2,150					5	11	109
Chlordane 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene, 60%, and related products		I	ec wp d g	L			ins.	pet oils s.							475		v. per soil	v. tox		5	1-3	65
Chlordimeform N-(4-Chloro-o-tolyl)-N,N-dimethylformamidine		M I	ec d	S	35	~226	0.25%		Me >20%		~226			hyd alk acd	250					1-3	7	99
Chlorfenvinphos 2-Chloro-1-(2,4-dichlorophenyl)vinyldiethyl-phosphate		I	ec d g	L	-19	169 0.5	sl.s.	ker mis	Et mis	ace xyl mis			hyd		25	Rb 420				1-3	7	65
Chlorflurenol Methyl 2-chloro-9-hydroxy-fluorene-9-carboxylate		PGR	ec	S	152		.0028 g/100 ml		Et 8 Me 15 g/100 ml	ace 26 bz 7 g/100 ml	dec				5,000					11	12	130
Chlorobenzilate Ethyl 4,4'-dichlorobenzilate		I	wp ec	S	36	157 .07 mm	ins.	pet s.						hyd alk acd	700 to 3,100					5	8	105

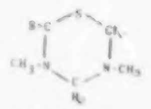
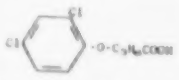
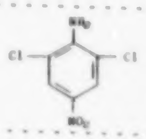
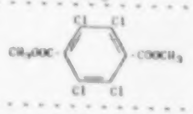
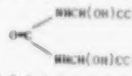
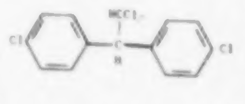
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Chloroform	 $\mathrm{Cl-\overset{H}{\underset{Cl}{C}}-Cl}$	Fu		L	-64	60			Et mis	bz mis					2,180					12	11,14	112
5-Chloro-2-mercaptobenzothiazole															>3,000					5	6,11	93
Chloroneb **1,4-Dichloro-2,5-dimethoxybenzene**		F	wp c g	S	134	268	8 ppm			ace 11.5% xyl 8.9%					>11,000					5	6,11	116
O-(p-(p-Chlorophenylazo)-phenyl) O,O-dimethyl phosphorothioate		I													>1,500	>1,500				7	11	67
S-(p-Chlorophenyl) O-ethyl ethanephosphonodithioate		I													6	96 359				1-3	9	71
o-Chlorophenyl N-methylcarbamate		I													mice 150					7	1-3	76
S-[(p-Chlorophenyl)thio]methyl O,O-diethyl phosphorothioate		I													mice 165					1-3	7	67
[(p-Chlorophenyl)thio](2,4,5-trichlorophenyl)diimide		I M									dec				mice 3,000					5	1-3	117
p-Chlorophenyl-2,4,5-trichlorophenyl sulfide		I		S	124		ins.								6,810	>2,000 Rb				5	1-3	117

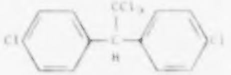
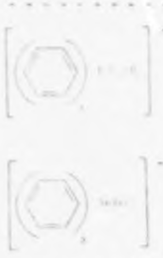
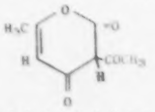
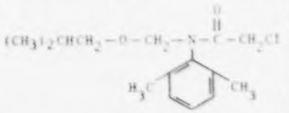
Common Name **Chemical Name**	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Pro-cedure No.	Alternate Pro-cedure No.	Additional Infor-mation Page No.
Chloropicrin **Trichloronitromethane**	CCl_3NO_2	Fu	v a	L	-64	112	2.3 g/1		m.s. mis	ace bz mis					0.8			tox		1-3	11	95
Chlorothalonil **2,4,5,6-Tetrachloro-1,3-dicyanobenzene**		F	wp f	S	250	350	.6 ppm	ker <1% w/w		ace 2% w/w					10,000					5	1-3	117
2-(4-Chloro-o-tolyl)oxy-N-methoxyacetamide		H		S	93		s.								175					7	11	86
Chloroxuron **3-[p-(p-Chlorophenoxy)-phenyl]-1,1-dimethylurea**		H	wp	S	152		2.7 ppm			ace m.s.					3,700					5	6	87
Chlorpropham **Isopropyl-m-chloro-carbanilate**		H	ec g	S	39		88 ppm	ker s.		dec before boil- ing 150					5,000		3-9 mo soil			1-3	5	76
Chlorpyrifos **O,O-Diethyl O-(3,5,6-trichloro-2-pyridyl)phosphorothioate**		I	ec wp g				2 ppm		Me 43% w/w						135-163					1-3	9	67
Ciodrin® **Dimethylphosphate of α-methyl-benzyl-3-hydroxy-cis-crotonate**		I	ec d	L		135 .03 mm	1%	ker sl.s.	i-Pr Et s.	xyl mis ace s.			hyd	dec acd alk	125	Rb 384				1-3	7	65
CMA **Methanearsonic acid, calcium hydrogen salt**	$Ca(CH_3AsO_3H)_2$	H	wml	S			.2%								4,000		pp			11	1-3	56

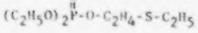
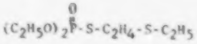
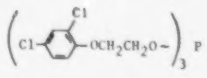
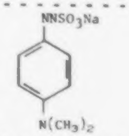
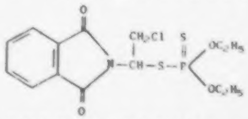
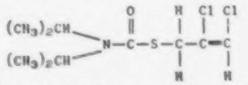
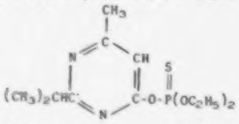
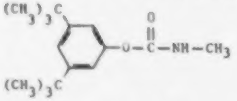
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Concern			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Copper arsenate (basic)	$CuAsO_4CuOH$	I F	wp	S			ins.										PP			11	1-3	56
Copper carbonate (basic)	$CuCO_3 \cdot Cu(OH)_2$	F	p	S			ins.			ins.							PP			11	1-3	58
Copper naphthenate Copper salt of mixed naphthenic acids		F	os	l			ins.		pet mod. s.	org s.					457		PP			11	1-3	58
Copper oleate Cupric oleate	$Cu[CH_3(CH_2)_7CH{=}CH(CH_2)_7COO]_2$	F	l					pet s.							500		PP		n	11	1-3	58
Copper oxychloride sulfate Cupric oxychloride sulfate	$3Cu(OH)_2 \cdot CuCl_2$ and $3Cu(OH)_2 \cdot CuSO_4$	F		S													PP			11	1-3	58
Copper 8-quinolinate Copper 8-hydroxyquinolinate		F	wsc d	S			s.										PP			11	1-3	58
Copper salts of rosin and fatty acids	Variable	F	ec	L			ins.		s.								PP			11	1-3	58
Copper sulfate Cupric sulfate pentahydrate	$CuSO_4 \cdot 5H_2O$	H	wsc				31.6 (0°)		Me s.	ins.	$-H_2O$ 110°				300		PP	tox		7,11	--	58
Copper zinc chromate	$15CuO \cdot 10ZnO \cdot 6CrO_3 \cdot 25H_2O$	F	wp	S			ins.								6,160		PP			11	1-3	58
Coumaphos O,O-Diethyl-O-(3-chloro-4-methyl-2-oxo-(2H)-1-benzopyran-7-yl)-phosphorothioate		I	wp ec d	S	93		ins.		sl.s.	org mis					230	1,000 mg/kg				1-3	7	67

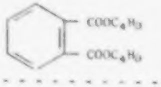
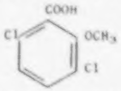
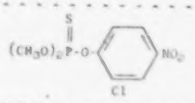
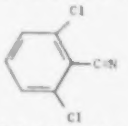
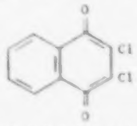
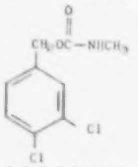
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
3-CP 2-(m-Chlorophenoxy)-propionic acid		H		S	114		.12 g/ 100g			ace 79g/ 100g					3,550					5	7,12	107
4-CPA 4-Chlorophenoxyacetic acid		PGR	wsc a	S	160		ins.		s.	ace s.										5	7,12	107
Creosote		I		L			sl.s.								tox					11	5	130
Crufomate O-(4-tert-Butyl-2-chlorophenyl) O-methyl methyl phosphoroamidate		I	ec c	S	62		ins.	pet ins.		ace bz s.	dec above 63				660- 1,000	skin			sl. tox	7	1-3	74
Cryolite Sodium aluminofluoride	Na_3AlF_6	I	wp	S	1,000		ins.							dec alk	not acute but 43 mg/ kg/day is tox					7	11	62
rous oxide	Cu_2O	F	d	S			ins.													11	1-3	58
Cyanomethylthiobenzothiazole																				5	1-3	93
Cyanophenyl O-(p-Cyanophenyl) O-ethyl phenyl-phosphonothioate		I	ec	S	83		ins.	v.s.	m.s.			st	st		89 mg/ kg	2,000 mg/kg				1-3	7	67
Cyanophos O-(p-Cyanophenyl) O,O-dimethyl phosphorothioate		I	ec d wp	L			<0.1	v.s.	v.s.			st	st		610mg/ kg	800 mg/kg				7	1-3	67
Cycloate S-Ethyl N-ethyl-N-cyclohexylthiocarbamate		H	ec K	L		146 10mm	85 ppm	ker mis		xyl mis					3,190					5	6,11	79

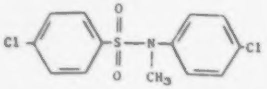
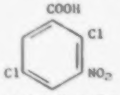
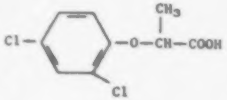
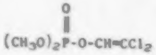
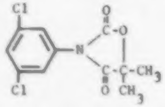
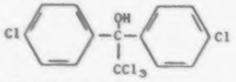
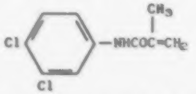
Common Name **Chemical Name**	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Cycloheximide 3-[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]-glutarimide		F	wp	S	116		2.1g/ 100ml		i-Pr s.	org s.	st			dec alk st acd	2.5					7	11	85
Cycocel® 2-Chloroethyltrimethylammonium chloride	$[ClCH_2CH_2N(CH_3)_3]^+Cl^-$	PGR	wml	S	dec		74%	ins.	s.						670					5	11,13	98
Cyolane® Cyclic ethylene ester of diethoxyphosphinyl dithioimidocarbonic acid		I M	ec g	S	41		s.		Et s.	ace bz s.				hyd alk	8.9					1-3	7	74
Cypracine 2-Chloro-4-(Cyclopropylamino)-6-(isopropylamino)-s-triazine		H	ec	S	167- 168 °C		ins.	sl.s.	m.s						1,200					1-5	6,7	89
Cypromid 3',4'-Dichlorocyclopropanecarboxanilide		H	ec	S	131		ins.	sl.s						hyd alk	215					1-3	5	80
Cythioate O,O-Dimethyl O-p-sulfamoylphenyl phosphorothioate		I		S	86		s.								160					1-3	7	67
2,4-D 2,4-Dichlorophenoxyacetic acid (disposal information applies to 2,4-D derivatives also)		H	ec g	S	136	160 4mm	.06/ 100g		i-pr 31.6 g/ 100g	ace 45g/ 100g		dec sl in uv			300- 1,000					5	7,12	107
Dalapon 2,2-Dichloropropionic acid, sodium salt	CH_3CCl_2COONa	H	sp	L	17.5	dec	v.s. hyd >50°						hyd slowly	dec alk >120°	9,330		1 mo			7	5	112

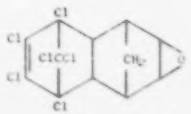
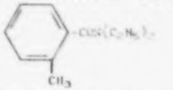
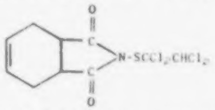
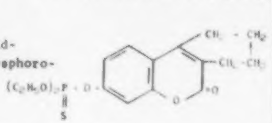
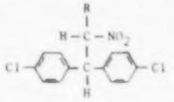
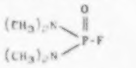
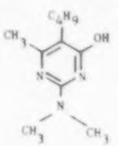
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Dazomet Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione		F H N	d	S	100		.12%			ace 19%	some dec 100		dec		500					5	1-3 8	93
2,4-DB 4-(2,4-Dichlorophenoxy)-butyric acid (disposal information applies also to salts and esters)		H	ec	S	120		40 ppm		v.s.	ace v.s. bz sl.s.					500					5	7,12	107
DBCP 1,2-Dibromo-3-chloropropane	$ClCH_2CHBrCH_2Br$	Fu N	ec g	L		196	sl.s.	mis	i-Pr mis						173- 275	Rb 1,400				5	11	113
DCNA 2,6-Dichloro-4-nitroaniline		F	wp d	S	193		ins.		Et 2%	ace 3.4%					>10,000					1-4	5	95
DCPA Dimethyl-2,3,5,6-tetrachloroterephthalate		H	wp g	S	156		.5 ppm			ace bz 16% 25%	dec 365				3,000		n	not n tox 500 ppm		5	1-3	117
DCU 1,3-Bis(2,2,2-trichloro-1-hydroxyethyl)urea	 $O=C(NHCH(OH)CCl_3)_2$	H	wp	S	191		sl.s.				dec starts 191				6,680					5	1-3 11	87
D-D® Dichloropropenes and 1,2-dichloropropane	$C_3H_4Cl_2$ and $C_3H_6Cl_2$	Fu N	d	L	~125		sl.s. s.								140	Rb 2,100		n		1-3	11,12	112
DDD 1,1-Dichloro-2,2-bis(-p-chlorophenyl)ethane		I	ec wp d	S	112	190 1.1 mm	ins.				ace 100g/ 100cc bz 92g/ 100cc				3,400		per			5	1-3	105

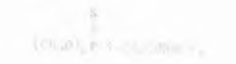
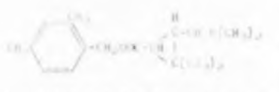
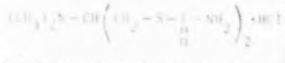
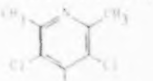
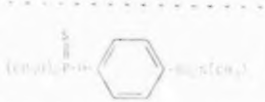
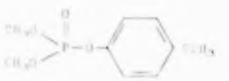
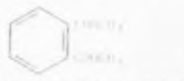
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Impact			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
DDT 1,1,1-Trichloro-2,2-bis-(p-chlorophenyl)ethane		I	ec wp d g	S	108		ins.	pet m.s.		bz 106%					113		per			5	1-3	102
n-Decanol	$CH_3(CH_2)_8CH_2OH$	I	ec	L	?	229	ins.	mis	mis				st		>10,000					13	11,12	130
Decyltriphenylphosphonium bromo-chlorotriphenylstannate		F		S	115		600 ppm								700 to 800					11	1-3	75
Def® S,S,S-Tributylphosphorotrithioate	$(CH_3CH_2CH_2CH_2S)_3P=O$	H	ec	L	<-25	150 .3mm	ins.		s.					hyd alk	325	>1,000				7	1-3	75
Dehydroacetic acid 3-Acetyl-6-methyl-2,4-pyrandione		F		S	109	270	ins.	Et sl.s.	ace bz s.						1,000			n		6	11	128
Delachlor 2-Chloro-N-(isobutoxymethyl)-2',6'-acetoxylidide		H	ec	L v		138	59 ppm		xyl s.						1,775					5	6	83

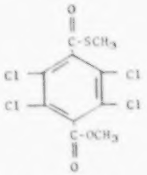
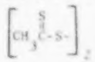
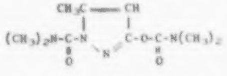
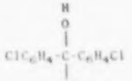
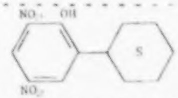
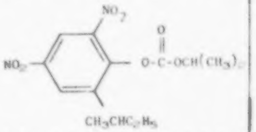
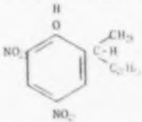
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Demeton Mixture 2:1 of (I) 0,0-Diethyl O-[2-(ethylthio)ethyl]phosphorothioate and (II) 0,0-Diethyl S-[2-(ethylthio)ethyl]phosphorothioate	 $(C_2H_5O)_2\overset{S}{P}\text{-O-}C_2H_4\text{-S-}C_2H_5$  $(C_2H_5O)_2\overset{O}{P}\text{-S-}C_2H_4\text{-S-}C_2H_5$	I M	ec wp	L	<-25	100° .4mm	1,000 ppm			org s.			hyd by H_2O at 100°C		6-12	14		tox	tox	1-3	7	67
2,4-DEP Tris[2-(2,4-dichlorophenoxy)-ethyl]phosphite		H	wp g	L		200 .1mm	ins.	ker del 10,000 ppm		xyl mis			hyd	hyd acd	850		m			1-3	8	75
Dexon® p-Dimethylaminobenzenediazo-s-sodium sulfonate		F	wp g	S	dec			3%		org ins.	dec 200	dec	dec	dec alk	60	>100				7	12	99
Dialifor 0,0-Diethyl S-(2-chloro-1-phthalimidoethyl)phosphorodithioate		I	ec	S	68		ins.		sl.s.	ace xyl s.					5					1-3	7	71
Diallate S-(2,3-Dichloroallyl)-diisopropylthiocarbamate		H	ec g	o L	28	150 9mm	14 ppm	ker mis	Et i-Pr mis	ace bz xyl mis	dec 210				395		over 1 yr		m	5	1-3 11	79
Diazinon® 0,0-Diethyl 0-(2-isopropyl-6-methyl-4-pyrimidinyl)-phosphorothioate		I	wp ec g a	o L		84 .002 mm	.004%	pet s.	Et mis	ace xyl mis	dec 120				150- 600			tox esp. ducks geese		1-3	7	67
3,5-Di-t-butylphenyl N-methylcarbamate																>4,000				7	1-3	76

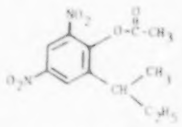
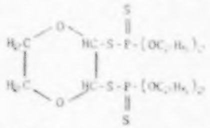
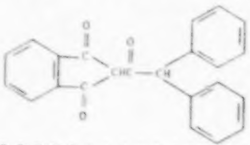
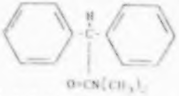
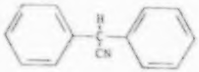
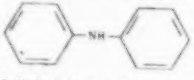
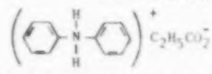
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Di-n-butylphthalate		R		L visc	-35	>330	400 ppm		Et mis	org mis				hyd alk	>20,000					12	11	130
Dicamba 3,6-Dichloro-o-anisic acid		H	g	S	115		.45 g/ 100g		Et 92 g/ 100g	xyl 7.8 g/ 100g					2,900					5	11	116
Dicapthon O-(2-Chloro-4-nitrophenyl) O,O-dimethylphosphorothioate		I	wp d ec	S	52		ins.			org s.					400					1-3	7	67
Dichlobenil 2,6-Dichlorobenzonitrile		H	wp g	S	146	270 760 mm	18 ppm			ace 7% w/v		st uv			>3,160					5	1-3	116
Dichlone 2,3-Dichloro-1,4-naphthoquinone		F	d wp	S	193	275 2mm	.1 ppm			ace bz sl.s. xyl s.				dec alk	1,300					5	1-3 11	116
Dichlormate 3,4-Dichlorobenzyl N-methylcarbamate		H		S	52		170 ppm	ins.		ace bz s.	slow dec >150				1,870					7	1-3	76
Dichloroethyl ether	$(ClCH_2CH_2)_2O$	Fu		L		178	ins.			org mis					105					5	12	119
Dichloromethane	CH_2Cl_2	Fu		L	-97	40	sl.s.	s.	s.	org s.										12	14	112

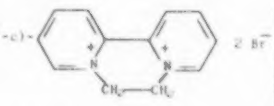
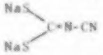
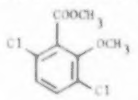
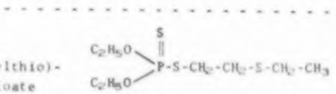
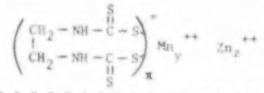
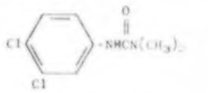
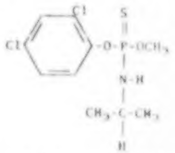
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
4,4'-Dichloro-N-methylbenzenesulfonanilide		Syn		S			ins.								2,500					5	1-3	122
2,5-Dichloro-3-nitrobenzoic acid		H		S	220		sl.s.								3,500					1-3	5,11	95
Dichloroprop 2-(2,4-Dichlorophenoxy) propionic acid		H	wsc ec	S	118		.71 g/ℓ		i-Pr 510 g/ℓ	ace 595 g/ℓ bz 85 g/ℓ					800					5	7,12	107
Dichlorvos 2,2-Dichlorovinyl dimethylphosphate	 $(CH_3O)_2\overset{O}{\overset{\Vert}{P}}\text{-O-CH=CCl}_2$	I M	ec g s b	L		84 1mm	1%		mis	bz chlor mis				dec acd alk	56-80	Rb 131-218		tox		1-3	7	65
Dichlozoline 3-(3,5-Dichlorophenyl)-5,5-dimethyl-2,4-oxazolidinedione		F																		5	1-3 11	91
Dicofol 1,1-bis(p-Chlorophenyl)-2,2,2-trichoroethanol		M	ec wp g	S	79	225 mm	ins. s.							hyd alk	809					5	7	105
Dicryl 3',4'-Dichloro-2-methylacrylanilide		H	ec	S	124		ins.			ace 20% xyl 25%					~3,160		>6 mo	n	n	5	1-3	83

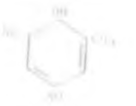
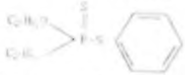
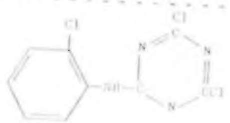
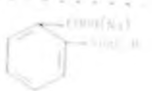
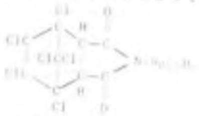
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD$_{50}$	Acute Dermal LD$_{50}$	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Dieldrin 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-exo-5,8-dimethanonaphthalene		I	ec wp d g	S	176		ins.		me sl.s.	xyl s.					60	v tox skin Rb >100		tox	tox	1-3	5	109
Diethyltoluamide N,N-Diethyl-m-toluamide		R	a	L		111 1mm	ins.		Et i-Pr mis						2,000					7	11	86
Difolatan® cis-N-[(1,1,2,2-Tetrachloroethyl)thio]-4-cyclohexene-1,2-dicarboximide		F	p d	S	160		1.4 ppm			ace 4.3 g/ 100ml	slow dec 160				6,200					7	11	85
2-(2,4-Dihydroxyphenyl)-1-cyclohexene-1-carboxylic acid-δ-lactone, O,O-diethyl phosphorothioate	 CH$_2$ - CH$_2$ CH$_2$-CH$_2$ (C$_2$H$_5$O)$_2$P - O S O O	I													67-300	>200				1-3	7	67
Dilan® 1,1-Bis(4-chlorophenyl)-2-nitropropane and 1,1-bis(4-chlorophenyl)-2-nitrobutane mixture	 R = CH_3CH_2 or CH_3	I	ec wp	semi S	~65		ins.	pet sl.s.	Et sl.s. Me s.	org sl.s.					475 to 8,073					5	6	105
Dimefox Bis(dimethylamino)-fluorophosphine oxide	 $[(CH_3)_2N]_2P(=O)F$	M	ec wp	L		67 4mm	mis			org mis					1 to 2					1-3	8	74
Dimethirimol 5-Butyl-2-(dimethylamino)-6-methyl-4-hydroxypyrimidine	 C$_4$H$_9$ CH$_3$ OH N N N CH$_3$ CH$_3$	F	aq	S	102		0.12g/ 100ml	36g/ 100ml xyl	6.5g/ 100ml Et					>4,000	>400					5	1-3 11	91

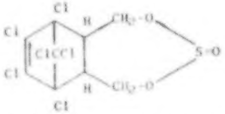
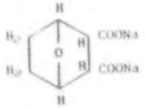
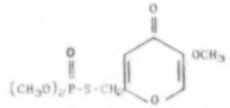
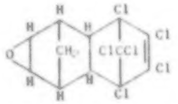
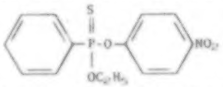
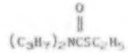
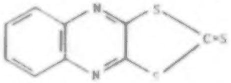
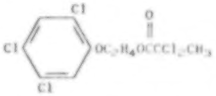
Common Name Chemical Name	Structural Formula	Description: Use	Description: Formulations	Description: Physical Form	Description: Melting Point	Description: Boiling Point	Solubility: Water	Solubility: Hydrocarbons	Solubility: Alcohols	Solubility: Other	Stability: Heat	Stability: Light	Stability: Moisture	Stability: Other	Toxicity: Acute Oral LD$_{50}$	Toxicity: Acute Dermal LD$_{50}$	Environmental Comment: Persistence	Environmental Comment: Fish	Environmental Comment: Wildlife	Disposal Procedure: Preferred Procedure No.	Disposal Procedure: Alternate Procedure No.	Disposal Procedure: Additional Information Page No.
Dimethoate O,O-Dimethyl S-(N-methylcarbamoylmethyl)phosphorodithioate	 $(CH_3O)_2\overset{S}{\overset{\Vert}{P}}-S-CH_2CONHCH_3$	I	ec wp c	s	52		2.5g 100ml			org s.					550		n 1/2 life of 2-4 days	n	n	1-3	7	71
Dimethrin[2] 2,4-Dimethylbenzyl-2,2-dimethyl-3-(2-methylpropenyl)-cyclopropanecarboxylate		I	a os ec	l		175 3.8 mm	ins.	mis	s.	s.				dec alk	40,000					7	6,11	125
S,S'-2-(Dimethylamino)-trimethylene-bis(thiocarbamate) hydrochloride	 $(CH_3)_2N-CH\left(CH_2-S-\underset{O}{\underset{\Vert}{C}}-NH_2\right)_2\cdot HCl$	I													250					5	1-3 11	79
2,6-Dimethyl-3,5-dichloro-4-pyridinol		I																		5	1-3	91
O,O-Dimethyl O-p-(dimethylsulfamoyl) phenyl phosphorothioate		I													35					1-3	7	67
Dimethyl-p-(methylthio)phenylphosphate		I		l			987 ppm		Et 86 g/ 100 ml	ace 89 g/ 100 ml xyl 100 g/ 100 ml	dec 269				7					1-3	7	65
Dimethyl phthalate		R	ec wp	l		284	.43% w/w	pet s.	Et mis	org mis				hyd alk	8,200					12	11	130

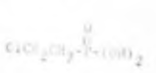
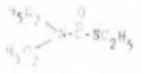
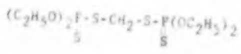
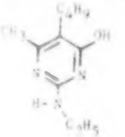
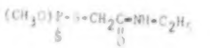
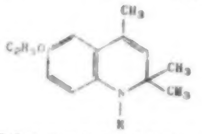
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
O,S-Dimethyltetrachlorothioterephthalate		H	wp	S	162	s.			Et 1.6 g/ 100 ml	ace 11.8 g/ 100 ml		some dec uv			3,000					5	1-3	117
Dimethyl thiocarbonyl disulfide		F																		11	1-3	121
Dimetilan 2-Dimethylcarbamyl-3-methyl-5-pyrazoyl dimethylcarbamate		I		S	70	205 13mm	s.		Et s.	ace xyl s.					47-64					1-3	7	76
Dimite® 4,4'-Dichloro-α-methylbenzhydrol	 $ClC_6H_4-C(OH)(CH_3)-C_6H_4Cl$	M I	c	S	70		ins.			org s.				acid unstable	1,100					5	11	105
Dinitrocyclohexylphenol 4,6-Dinitro-6-cyclohexylphenol		I M	d we	S	106		sl.s.			org s.					180					11	5	95
Dinobuton 2-sec-Butyl-4,6-dinitrophenyl isopropyl carbonate		M		S	62		ins.	s.	Et s.						140					11	5	95
Dinoseb 2-sec-Butyl-4,6-dinitrophenol		H	C	S L	32		.005 g/ 100g			xyl mis					5-60			tox		5	1-3	95

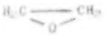
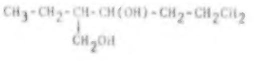
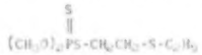
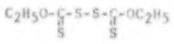
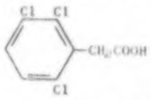
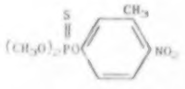
		Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
Common Name Chemical Name	Structural Formula	Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Dinoseb acetate 2-sec-Butyl-4,6-dinitrophenyl acetate		H	ec wp	L		170 4mm									65					5	1-3	95
Dioxathion 2,3-p-Dioxanedithiol S,S-bis(O,O-diethyl phosphorodithioate		I M	ec wp	L	-20		ins.		s.	ace bz xyl s.					43					1-3	7	71
Diphacinone 2-Diphenylacetyl-1,3-indandione		Ro	b cc	S	146		ins.			ace s.					cats 15				tox	5	4,11	132
Diphenamid N,N-Dimethyl-2,2-diphenyl acetamide		H	wp g	S	135	360	260 ppm			ace m.s.	dec 360				1,250			tox		7	11	86
Diphenatrile Diphenylacetonitrile		H	g	S	74		s.			org s.					3,500					11	6	99
Diphenylamine		I F	s wp	S	53	302	ins.		s.	ace bz s.			dec							5	1-3	99
Diphenylammonium propionate	 $(C_6H_5-NH_2-C_6H_5)^+\,C_2H_5CO_2^-$	F																		5	11	98

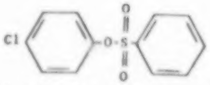
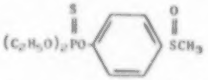
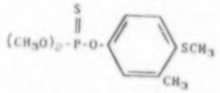
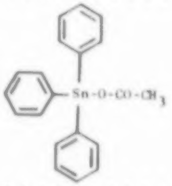
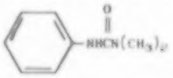
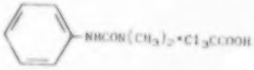
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Diquat® 6,7-Dihydrodipyrido(1,2-a:2',1'-c)-pyrazinediinium dibromide		H	wp	S			s.				dec high temp	dec uv			440					11	5	98
Disodium cyanodithioimido carbonate		F																		1-3	11	123
Disugran Methyl 3,6-dichloro-o-anisate		PGR																		5	1-3 11	116
Disulfoton O,O-Diethyl S-[2-(ethylthio)-ethyl]phosphorodithioate		I	ec g	L		62 .01 mm	23 ppm			org s.					12.5	20 mg/kg	n	tox		1-3	7	71
Dithane M-45® Complex of zinc and maneb		F	wp	S			ins.			org ins.	dec high temp		dec	dec by acid	8,000					8	1-4	80
Dithane S-31® Mixture of nickel sulfate and maneb		F	wp	S			s.								2,780					8	1-4	80
Diuron 3-(3,4-Dichlorophenyl)-1,1-dimethylurea		H	wp	S	158		42 ppm			bz 1,200 ppm	dec 185				3,400					5	6	87
DMPA O-(2,4-Dichlorophenyl) O-methyl isopropylphosphoroamidothioate		H	ec g	S	51		.0005 g/ 100g			me 126.6 g/ 100g	ace 451 bz 291 g/ 100g	dec 150			270					1-3	--	74

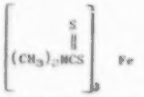
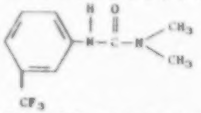
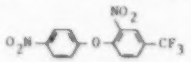
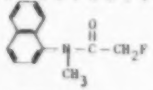
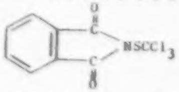
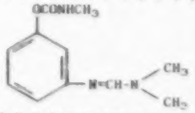
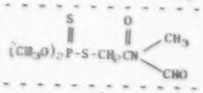
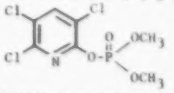
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Impact			Disposal Procedure		
		Use	Formulations	Physical State	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
DNOC 2-Methyl-4,6-dinitrophenol		H I	wsc ec	S	86	312	130 ppm								25-40					5	1-3	95
Dodine Dodecylguanidine acetate	[illegible]	F	wp d	S	136		s.		sl s.	org ins.					660- 875				0	6	11	99
DSMA Disodium methanearsonate	$CH_3AsO(ONa)_2$	H	wsc wp	S	136		25% w/w		Me s.		dec high temp				1,800					11	1-3	56
Dyfonate® O-Ethyl S-phenyl ethylphosphonodithioate		I	ec g	L		130 1mm	ins.			org mis					8-18					1-3	9	71
Dyrene® 2,4-Dichloro-6-(2-chloroaniline)-1,3,5-triazine		F	wp d g	S	160		ins. s.			org s.					2,710					1-3	6	89
EDB Ethylene dibromide	CH_2BrCH_2Br	I N	ec	L	9	132	.43 g 100g		Et s.	org s.					146					5	11	115
EGT Ethylene glycol bis (trichloroacetate)	$CCl_3\overset{O}{\overset{\|}{C}}OCH_2CH_2O\overset{O}{\overset{\|}{C}}CCl_3$	H	ec	S	40	156 2mm	ins.								7,000					11	5	112
Elcide® 73 Ethylmercurithiosalicylic acid (also sodium salt)		F	wsc	S			s.		s.						25					1-3	--	56
EMMI® N-Ethylmercuri-1,2,3,6-tetrahydro-3,6-endomethano-3,4,5,6,7,7-hexachlorophthalimide		F	ec wp	S	191		ins.		sl s.						148					1-3	--	56

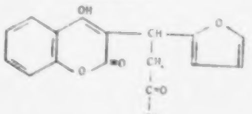
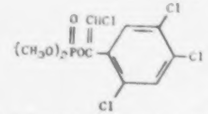
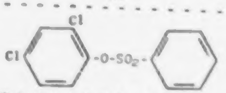
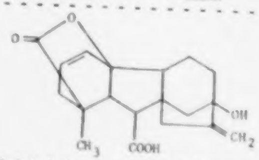
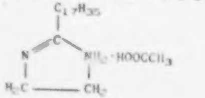
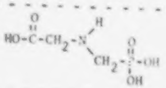
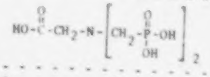
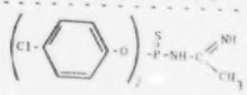
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Endosulfan 6,7,8,9,10,10-Hexachlor-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzo-dioxathiepin-3-oxide		I	ec wp d g	S	85	dec	ins.	ker s.	s.	org mis	dec			dec acd alk forms SO_2	110			v tox		5	1-3	109
Endothall 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid, disodium salt		H	wsc g	S	144		10g/ 100g		Me 26g/ 100g	ace 7g/ 100g	dec at m.p.	st uv			38-51					11	5	130
Endothion S[5-Methoxy-4-oxo-4H-pyran-2-y)methyl]O,O-dimethyl-phosphorothioate		I	wp	S	90		150g/ 100ml	ker ins.	Et s.	org s.					30-50					1-3	7	67
Endrin 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-endo-5,8-dimethanonaphthalene		I Ro	ec wp d g	S	>200		ins.	pet sl.s	sl.s.	ace bz m.s.	some dec at m.p.				7.5- 17.5	Rb 50- 500	sl per	tox	tox	1-3	5	109
EPN® O-Ethyl O-p-nitrophenyl phenylphosphonothioate		M I	ec wp g	S	36		ins.			org ins.					35-45					1-3	7	67
EPTC S-Ethyl dipropylthio-carbamate	 $(C_3H_7)_2NC(=O)SC_2H_5$	H	ec g	L	235		370 ppm		Et mis	ace xyl mis					1,367		n			5	1-3 11	79
Eradex® 2,3-Quinoxalinedithio cyclic trithiocarbonate		M F	wp	S	180		ins.		Et sl.s.	sl.s.					3,400					5	6,11	93
Erbon 2-(2,4,5-Trichlorophenoxy)ethyl-2,2-dichloropropionate		H	ec	S	50	162 .5mm	ins.	ker s.	s.	ace xyl s.					1,120					5	7,12	107

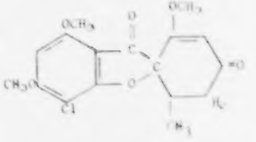
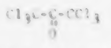
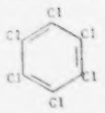
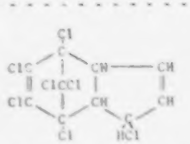
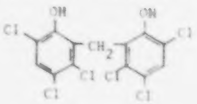
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Ethephon 2-Chloroethylphosphonic acid	 $ClCH_2CH_2-\overset{O}{\overset{\|}{P}}-(OH)_2$	H PGR	l											dec alk						7	11,4	65
Ethide® 1,1-Dichloro-1-nitroethane	$CCl_2(NO_2)-CH_3$	Fu	C	L		124	.25%								410					11	1-3	95
Ethiolate S-ethyl diethylthiocarbamate		H	ec	L	<-75	206	sl.s.				st to 206				400					5	1-3 11	79
Ethion O,O,O',O'-Tetraethyl S,S'-methylene bis(phosphorodithioate)	 $(C_2H_5O)_2\underset{S}{\underset{\|}{P}}-S-CH_2-S-\underset{S}{\underset{\|}{P}}(OC_2H_5)_2$	I M	ec g wp	L	-14		sl.s.	ker pet s.							208					1-3	7	71
Ethirimol 5-Butyl-2-(ethylamino)-4-hydroxy-6-methylpyrimidine		F	aq	S	159-160		ins.	ins.	sl.s.						4,000	>1,000				5	1-3 11	91
Ethoate-methyl S-[(Ethylcarbamoyl)methyl] O,O-dimethyl phosphorodithioate	 $(CH_3O)\underset{S}{\underset{\|}{P}}-S-CH_2\underset{O}{\underset{\|}{C}}-NH-C_2H_5$	I	ec wp d g	S	66		85%		Et v.s.	bz 63g/ 100g ace v.s.					340					1-3	7	71
Ethoxyquin 1,2-Dihydro-6-ethoxy-2,2,4-trimethylquinoline		F PGR	wp ec	L			ins.			org s.					900					5	1-3	91
Ethylene	$CH_2=CH_2$	PGR	cg	G		-181	ins.			ace bz s.										14	2	128

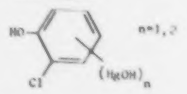
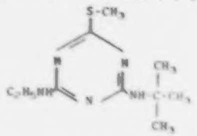
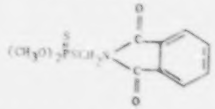
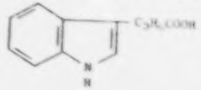
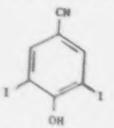
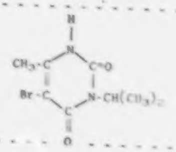
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Ethylene dichloride 1,2-Dichloroethane	CH_2ClCH_2Cl	Fu		L	-36	84	.43g/ 100ml			org s.					670-890					12	5	112
Ethylene oxide 1,2-Epoxyethane		Fu	cg	G	-111	11	mis													14	2	128
Ethyl formate	$HCOOC_2H_5$	Fu	ℓ	L	-80	54	m.s.		mis							8,000 ppm fatal inhaled 4 hr				11,5	6	128
Ethyl hexanediol 3-Hydroxymethyl-n-heptan-4-ol	 $CH_3-CH_2-CH(CH_2OH)-CH(OH)-CH_2-CH_2CH_2$	R	a	L	-40	244	.6%		Et mis						2,600 Rb					11,5	6	128
Ethylmercuric phosphate	$(C_2H_5Hg)_2HPC_4$	F																		1-3	--	54
Ethylmercury chloride	C_2H_5HgCl	F	d	S	192				alk s.						very tox			tox	tox	1-3	--	54
S-(2-(Ethylthio)ethyl) O,O-dimethyl phosphorodithioate	 $(CH_3O)_2P(=S)S-CH_2CH_2-S-C_2H_5$	I													40-225					1-3	7	71
EXD Di(ethoxythiocarbonyl) disulfide	 $C_2H_5O-C(=S)-S-S-C(=S)-OC_2H_5$	H	ec	S	32		<.5 ppm			ace 10% bz 25%				dec alk	603					11	1-3	122
Fenac® (2,3,6-Trichlorophenyl) acetic acid		H	g wsc	S	158		sl.s.		Et Me v.s.	ace v.s. bz s.					1,780		>1yr			5	1-3	117
Fenitrothion O,O-Dimethyl O-(4-nitro-m-tolyl)phosphorothioate		I	ec wp d g	L		143 .1mm	ins.			org s.	some dec at 141				250-500					1-3	7	67

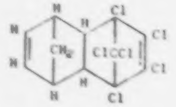
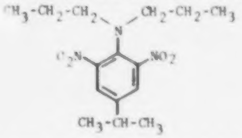
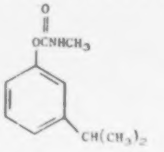
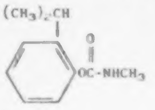
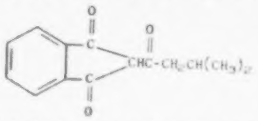
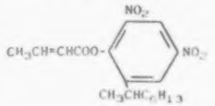
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Fenson® p-Chlorophenyl benzenesulfonate		M	wp	S	60		ins.								1,650					6,11	5	122
Fensulfothion O,O-Diethyl O-p-(methylsulfinyl)phenyl phosphorothioate		I N	ec wp d g	L		139 .01mm	ins.			org s.					4.6- 10.5					1-3	7	67
Fenthion O,O-Dimethyl O[4-(methylthio)-m-tolyl] phosphorothioate		I	ec wp d ulv g	L	<-25	105 .01 mm	ins.			org s.					~200					1-3	7	67
Fentin acetate Triphenyltin acetate		F H Mo	wp	S	120										140- 491					1-3	11	59
Fenuron 1,1-Dimethyl-3-phenylurea		H	wp g	S	134		3,850 ppm	sl.s.						hyd acd alk	6,400					5	6	87
Fenuron TCA 1,1-Dimethyl-3-phenylurea trichloroacetate		H	c d g ec	S	66		m.s.	sl.s. pet		ace m.s.		slow dec uv			4,000					11	1-3	87

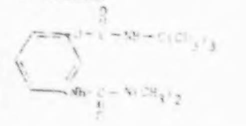
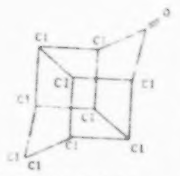
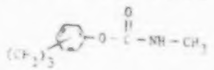
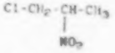
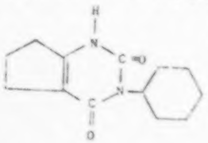
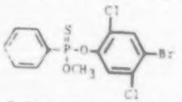
		Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
Common Name Chemical Name	Structural Formula	Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Ferbam Ferric dimethyldithiocarbamate		F	wp	S	>210		m.s.				Starts dec 180				>17,000					8	1-4	83
Fluometuron 1,1-Dimethyl-3-(α,α,α-trifluoro-m-tolyl)urea		H	wp	S	164		90 ppm		Et i-Pr s.	ace s.					8,900					11	1-3	87
Fluorodifen p-Nitrophenyl α,α,α-trifluoro-2-nitro-p-tolyl ether		H	ec	S	92		<2 ppm			ace s.					15,000					11	5	95
2-Fluoro-N-methyl-N-(1-naphthyl)-acetamide															mice 157					1-3	--	83
Folex® Tributylphosphorotrithioite	$[CH_3(CH_2)_3S]_3P$	H	ec	L	<0	125 .08 mm	m.s.	dal s.	Et s.	ace bz xyl s.					1,272					9	1-3	75
Folpet N-(Trichloromethylthio)-phthalimide		F	wp d	S	167	150 .02 mm	1 ppm			org s.					>10,000			n		7	11	85
Formaldehyde	HCHO	Fu	aq	G	-91	-21	s.		Et s.						800			tox		1-4	10,5	128
Formetanate m-[[(Dimethylamino)methylene]amino]phenyl N-methyl carbamate		M	wsc	S	102		<.1%		Me 20%	ace 10%	st 60°				24					1-3	7	76
Formothion O,O-Dimethyl S-(N-formyl-2-mercapto-N-methylacetamide	 $(CH_3O)_2\overset{S}{\overset{\|}{P}}\text{-S-}CH_2\overset{O}{\overset{\|}{C}}N(CH_3)CHO$	I M	ec	O	26		2,600 ppm		mis	bz mis					375-535	100-1,500				7	1-3	71
Fospriate Dimethyl 3,5,6-trichloro-2-pyridyl phosphate		I		S	93°	265 dec	ins.		Et m.s.	ace bz s.	265 dec				790 mg/kg					7	1-3	65

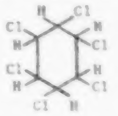
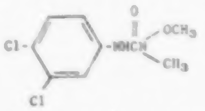
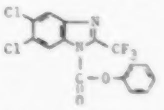
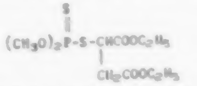
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Fumarin® 3-(α-Acetonylfurfuryl)-4-hydroxycoumarin		Ro	b d sp	S	23		Na salt s.			bz 7.3 g/100 g					40					5	4,11	132
Gardona® 2-Chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate		I M	wp ec d sol	S	96		is ppm			ace <20% xyl 8%	slow dec 250				4,500					7	11,4	65
Genite 923® 2,4-Dichlorophenylester of benzenesulfonic acid		M	ec	W	42		ins.			org s.					1,400					5,11	6	122
Gibberellic acid		PGR	sp sol ec wp	S	234		sl.s.		Me Et s.	ace s.					6,300					5,11	6	125
Glyodin® 2-Heptadecyl-2-imidazoline acetate		F	wp	W	294		ins.		i-Pr 39%					hyd alk	5,770					11	5,13	98
Glyphosate N-(Phosphonomethyl)glycine		H																		1-3	7	65
Glyphosine N,N-bis(Phosphonomethyl) glycine		PGR																		1-3	7	65
Gophacide® O,O-Bis(p-chlorophenyl)-acetimidoylphosphoroamidothioate		Ro	b	S	105		ins.		Et sl.s.	bz sl.s.			dec alk		7.5					1-3	7	74

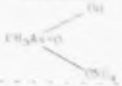
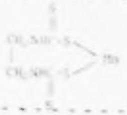
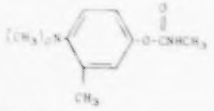
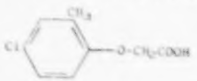
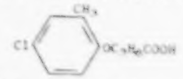
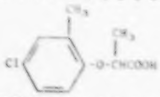
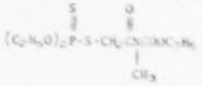
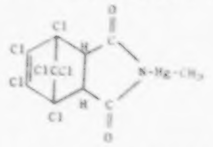
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD50	Acute Dermal LD50	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Griseofulvin 7-Chloro-4,6-dimethoxy-coumarin-3-one-2-spiro-1-(2'-methoxy-6'-methyl-cyclohex-2'-ene-4'-one)		F	d	S	sub 210		ins	pet ins												5	6,11	130
HCA 1,1,1,3,3,3-Hexachloro-2-propanone	 $Cl_3C-\underset{O}{\underset{\|}{C}}-CCl_3$	H	S	L	-2	204	sl.s.		s.	org s.					1,290				n	7	5	112
HCB Hexachlorobenzene		F	d g	S	227		ins.		sl.s	bz s.										5	1-3	117
Heptachlor 1,4,5,6,7,8,8-Heptachloro-3a,4,7a-tetrahydro-4,7-methanoindene		I	ec wp g s	S	96	135 1 mm	ins	ker 18-9 g/100 ml	Et 4.5 g/100 ml						130-135 skin		>1 yr			5	1-3	109
Hexachlorophene bis(3,5,6-Trichloro-2-hydroxyphenyl)methane		F		S	164		ins			org s.					m 168					5	1-3	117
Hexaflurate Potassium hexafluoro-arsenate	$KAsF_6$	H		S	440		12%								1,200-10,000					11	1-3	56
Hydrogen cyanide	HCN	Fu		G	-14	26 760 mm	s.		Et s.						300 ppm 30 min fatal					9	14	60

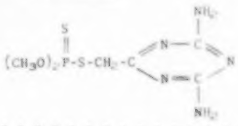
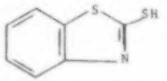
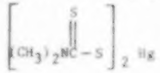
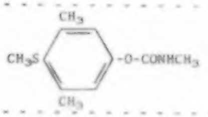
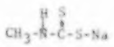
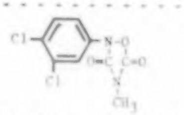
		Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
Common Name Chemical Name	Structural Formula	Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Hydroxymercurichlorophenol		F	S	S			s.											tox	tox	1-3		54
2-Hydroxypropylmethanethiosulfonate Methyl 2-hydroxypropylthiosulfonate	CH_3-CH(OH)-CH_2-SO_2-S-CH_3	F																		1-3	11	123
Igran 80W® 2-(tert-Butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine		H	wp	S	104		58 ppm		i-Pr s.	xyl s.		dec uv			2,700					1-5	6 7	89
Imidan® O,O-Dimethylphthalimidomethylphosphorodithioate		I M	ec wp	S	72		25 ppm			ace bz >10%	dec before bp				300					1-3	7	71
Indolebutyric acid Indole-3-butyric acid		PGR	sp	S	124		ins.			org s.							n			5	1-3	91
Ioxynil 4-Hydroxy-3-5-diiodobenzonitrile		H	wsc	S	dec		130 ppm		Me 3.3 g/100 ml	ace >10 g/100 ml							n			11	1-3	99
Isocil 5-Bromo-3-isopropyl-6-methyluracil		H		S	158 sub		2,150 ppm		Et 19.6 g/100g	ace s.		st	dec acd		3,400		n			5	11	87

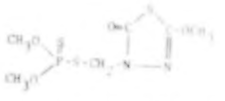
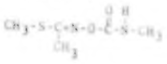
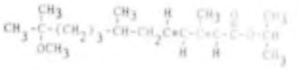
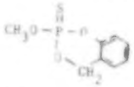
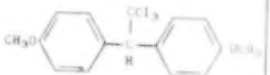
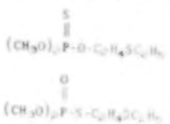
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Isodrin 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-endo-5,8-dimethanonaphthalene		I		S	240		ins.				dec 100				12-17					1-3	5	109
Isopropalin 2,6-Dinitro-N,N-dipropylcumidine		H	G ec	L		dec	10 µg/100 ml	> 100 g/ml	> 100 g/ml			dec by uv	st		> 5,000 mg/kg	> 2,000 mg/kg Rb				11	5	95
m-Isopropylphenyl-N-methylcarbamate		I		S	72		85 ppm		1-Pr 40%	ace 50% xyl 10%					41-63					7	1-3	76
o-Isopropylphenyl-N-methylcarbamate		I		S	92		1%			aces.					104					7	1-3	76
2-Isovaleryl-1,3-indandione		I Ro			68		ins. Na salts.			orgs.										5	6,11	130
Karathane® 4,6-Dinitro-2-(1-methylheptyl)phenyl crotonate		F M	wp g c	L		139 .05 mm	ins.			orgs.					980					5	11	95

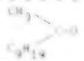
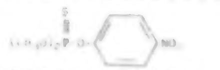
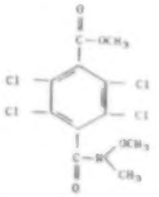
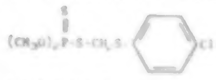
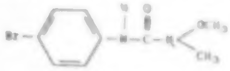
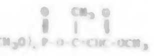
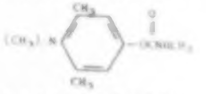
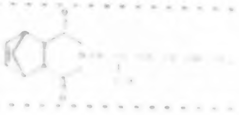
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Karbutilate m-(3,3-Dimethylureido) phenyl tert-butylcarbamate		T			116		325 ppm			org sl.s.					3,000					7	1-3	76
Kepone® Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta[cd]-pentalen-2-one		I	ec wp d g b	S	sub. 350		.4				some dec at 350				410			tox	tox	5	1-3	109
KOCN Potassium cyanate	KOCN	H	c	S	700-900		75g/100g		sl.s.						mice 850					7	11	60
Landrin® 2,3,5- and 3,4,5-Trimethyl-phenyl N-methylcarbamate		I	wp g	S	110		ins.								208	Rb > 2,500				7	1-3	76
Lanstan® 1-Chloro-2-nitropropane	 $Cl\text{-}CH_2\text{-}\underset{NO_2}{\underset{\vert}{CH}}\text{-}CH_3$	F	ec g	L		171	8,800 ppm			org s.					197		n	n		11	1-3	95
Lead arsenate	$PbHAsO_4$	I		S			ins.				dec 280		dec alk		1,050		per	tox	tox	11	1-3	56
Lenacil 3-Cyclohexyl-6,7-dihydro-1H-cyclopentapyrimidine-2,4(3H,5H)-dione		H	wp	S	316		6 ppm								11,000					6	11	87
Leptophos O-(4-Bromo-2,5-dichloro-phenyl)phenylphosphonothioate O-methyl		I	d gr wp c	S											52.8					1-3	7	67

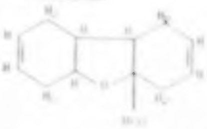
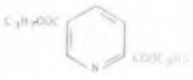
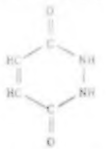
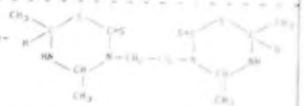
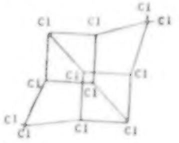
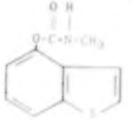
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Lethane® 384 beta-Butyoxy beta'-thiocyano diethyl ether	$C_4H_9O(CH_2)_2O(CH_2)_2SCN$	I	S c a	o		124 .25 mm	ins.	pet s.		org s.					90	skir				5, 9	1-3	123
Lime sulfur	$CaS \cdot S_x$	F		L										dec CO_2					n	11	12	62
Lindane 1,2,3,4,5,6-Hexachloro-cyclohexane (gamma isomer)		I	c	S	113	60 9.5 mm	ins.			ace bz s.	dec 288				90		per	tox		5	1-3	112
Linuron 3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea		H	wp g	S	94		73 ppm			ace 50%			dec moist soil	dec acd alk	1,500		<4 mo			5	11	87
London Purple A mixture containing calcium arsenite and calcium arsenate	Indeterminate	I																		11	1-3	56
Lovozal® 5,6-Dichloro-2-trifluoro-methylbenzimidazole-1-carboxylate		H	wp	S	103		13 ppm						hyd		283	>1,000 mg/kg rats				5	1-3	91
Magnesium arsenate	$Mg_3(AsO_4)_2$	I	d	S														tox	tox	11	1-3	56
Magnesium chlorate	$Mg(ClO_3)_2 \cdot 6H_2O$	H	wsc	S			s.		s.						5,250					11,13	10	62
Malathion S-[1,2-Bis(ethoxycarbonyl)-ethyl] O,O-dimethylphos-phorodithioate	 $(CH_3O)_2\overset{S}{\overset{\Vert}{P}}-S-\underset{CH_2COOC_2H_5}{\underset{\vert}{C}}HCOOC_2H_5$	I	ec d c ulv	L	3	156 .7 mm	145 ppm				dec high temp.				1,400 2,800	>4,000				7	1-3	71

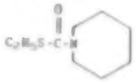
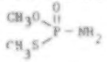
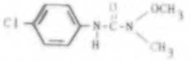
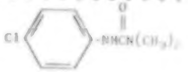
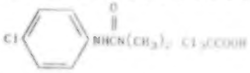
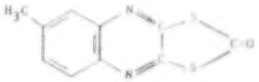
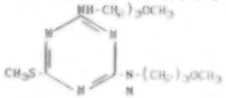
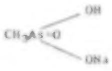
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
MAMA Monoammonium methyl arsenate	 $CH_3As(=O)(OH)(ONH_4)$	H	wsc												720					11	1-3	56
Maneb Manganese ethylene bis dithiocarbamate		F	wp	S			n.s.				dec before op		dec		6,750					8	1-3	80
Matacil® 4-Dimethylamino-m-tolyl N-methylcarbamate		I M Mo	wp d ec	S	94		sl.s.								30					7	1-3	76
MCPA 2-Methyl-4-chlorophenoxyacetic acid		H	d wsc ec	S	148		ins.		Et 153 g/100 ml	xyl 5 g/100 ml					700					5	7,12	107
MCPB 4-(2-Methyl-4-chlorophenoxy)butyric acid		H	wsc ec cd	S	100		40 ppm		15%	ace >20%					700-1,000					5	7,12	107
MCPP 2-(2-Methyl-4-chlorophenoxy)-propionic acid		H	wp ec	S	94		620 ppm		s.	ace bz s.					930			n	n	5	7,12	107
Mecarbam Diethyl S-(N-ethoxycarbonyl-N-methylcarbamoylmethyl)-phosphorodithioate	 $(C_2H_5O)_2P(=S)\text{-}S\text{-}CH_2C(=O)N(CH_3)COOC_2H_5$	I M	ec wp d	oil L		144 .02 mm	<.1%		mis	xyl					36					1-3	7	71
Memmi® 3,4,5,6,7,7-Hexachloro-N-(methylmercuri)-1,2,3,6-tetrahydro-3,6-methanophthalimide		F	wsc	S	226		ins.	sl.s.	n.s.	ace vis					155					1-3	--	56

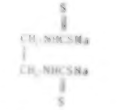
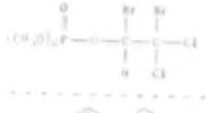
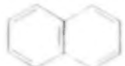
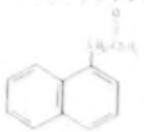
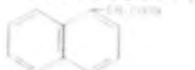
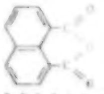
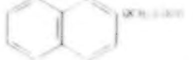
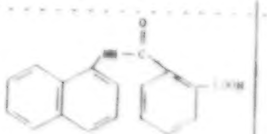
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Menazon S-(4,6-Diamino-s-triazin-2-ylmethyl)O,O-dimethylphosphorodithioate		I M	wp s	S	160		.024 g/ml				dec 170				1,950					7	1-3	71
2-Mercaptobenzothiazole 2-Benzothiazolethiol		F		S	179		i		s	org s.										5	1-3	93
Mercuric dimethyldithiocarbamate	 $[(CH_3)_2NC(=S)-S]_2Hg$	F																		1-3	--	54
Mercury chlorides Mercuric chloride	$HgCl_2$	F	wsc	S	277	302	6.1 g/ 100 cc		3.3 g/ 100 cc			dec			37			tox	tox	1-3	--	54
Mercurous chloride	Hg_2Cl_2	F		S	sub. 400- 500		0.002 g/ℓ						dec		>210					1-3	--	54
Mesurol® 4-Methylthio-3,5-xylyl N-methylcarbamate		I M	wp b	S	121		ins.			org s.				hy- drol al- kali hdl	100			tox	tox	7	1-3	76
Metaldehyde	$(CH_3CHO)_n$	Mo	d b s	S	sub. 115		200 ppm		1.8 g/ 100 ml	bz sl.s.					600- 1,000			tox		4	6	128
Metham Sodium methyldithiocarbamate	 $CH_3-NH-C(=S)-S-Na$	N F H	c	S			72.2 g/ 100 ml		Et m.s.	org ins.			dec		820		2 wks			8	1-3	80
Methazole 2-(3,4-Dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione		H	wp	S											1,350					5	11	91

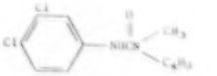
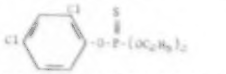
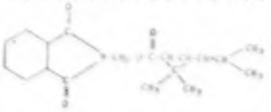
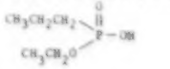
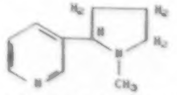
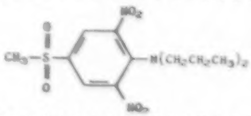
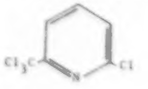
Common Name **Chemical Name**	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Methidathion O,O-Dimethyl S-(2-methoxy-1,3,4-thiadizol-5(4H)-onyl-4-methyl phosphorodithioate		I	ec	S	39-40		<0.1 %		v.s. me	v.s. xyl				st acd dec alk	65 mg/kg	540 mg/kg		tox		1-3	7	71
Methomyl S-Methyl-N[(methylcarbamoyl)oxy]thioacetimidate	 $CH_3-S-\underset{CH_3}{C}=N-O-\overset{O}{C}-\overset{H}{N}-CH_3$	I N	wsc	S	78		5.8 g/100 ml		Et 42g/100g Me 100g/100g	ace 77g/100g					17-24					1-3	7	76
Methoprene Isopropyl (2E,4E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate	 $CH_3-\overset{CH_3}{\underset{OCH_3}{C}}-(CH_2)_3-\overset{CH_3}{CH}-CH_2\overset{H}{C}=\underset{H}{C}-\overset{CH_3}{C}=\underset{H}{C}-\overset{O}{C}-O-\overset{CH_3}{\underset{CH_3}{CH}}$	I	ec gl	L		100 0.05 mm	1.39 ppm	v.s.	v.s.						> 34,600 mg/kg	> 3,500 mg/kg Rb				13	6,11, 12	110
2-Methoxy-4H-1,3,2-benzodioxaphosphorin-2-sulfide		I													91					1-3	--	67
Methoxychlor 1,1,1-Trichloro-2,2-bis-(p-methoxyphenyl)ethane		I	ec wp d t g	S	77		ins.	pet s.s.	Et s.s.					hyd alk	6,000	skin	per	tox		5	11	105
Methyl bromide	CH_3Br	N	fg	G	-93.6		134 g/100g			org s.					safe limit 17 ppm	skin burn	per Br			1-3	16	115
Methyl demeton S-[2-(Ethylthio)ethyl]-O,O-dimethyl phosphorothioate and O-[2-(ethylthio)ethyl]O,O-dimethylphosphorothioate	 $(CH_3O)_2\overset{S}{\overset{\|}{P}}-O-C_2H_4SC_2H_5$ $(CH_3O)_2\overset{O}{\overset{\|}{P}}-S-C_2H_4SC_2H_5$	I M	ec ulv	L	<10	106 .01 mm	<1%	pet ins.		org s.				hyd alk	50	630 mg/kg				1-3	7	63
Methylmercuric hydroxide	CH_3HgOH	F																		1-3	--	54
3-Methyl-(mercurithio)-1,2-propanediol	$CH_3HgS-CH_2-CH(OH)-CH_2OH$	F																		1-3	--	54

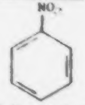
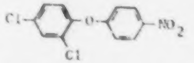
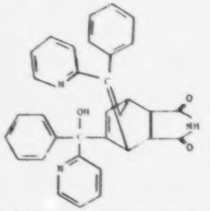
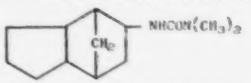
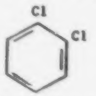
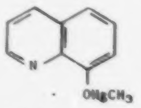
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical State	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Methylmercury nitrile	CH_3HgCN	F		S	91		200g /l		s	org s.	> 100									1-3	--	56
Methyl nonyl ketone		R	e	L	16	223	Ins.	pet s.	s.						10,000	>9.4 mg/kg				13	6,11, 12	XXX
Methyl parathion O,O-Dimethyl-O-p-nitrophenylphosphorothioate		I	ec wp d	S	36		60 ppm	pet sl.s.			dec 120			hyd alk	14-24	skin	n	tox	tox	1-3	7	67
Methyl-2,3,5,6-tetrachloro-N-Methoxy-N-methylterephthalamate		H		S	96		5 ppm		Et 53 g/ 100 ml	ace 120 g/ 100 ml	dec 250			hyd alk	1,170					5	1-3	99
Methyl trithion S-[[(p-Chloro-phenyl)thio]-methyl]O,O-dimethyl phosphorodithioate		I	ec d	L	-18		1 ppm			org mis					150	6,000				1-3	7	71
Metobromuron 3-(p-Bromophenyl)-1-methoxy-1-methylurea		I H	g wp	S	96		330 ppm		Et s.	ace s.						2,000				5	6	87
Mevinphos 2-Methoxycarbonyl-1-methylvinyl dimethyl phosphate	 $(CH_3O)_2P(=O)-O-C(CH_3)=CHC(=O)-OCH_3$	I M	ec d g wsl	L	~16	101 .3 mm	mis		mis					dec by lime sul-fur	8-12	Rb 16-34	n	tox	tox	1-3	7	65
Mexacarbate 4-Dimethylamino-3,5-xylyl N-methylcarbamate		I	ec wp	S	85	231-232 °C	0.1%	s.s.	s.s.	org s.			dec water	dec alk	15-63	> 1,950 Rb				7	1-3	76
MGK 264® N-(2-Ethylhexyl)bicyclo-[2.2.1]-5-heptene-2,3-dicarboximide		Syn	e a	L	-20	150 2mm	Ins.	ker mis							2,800	skin				7	11	85

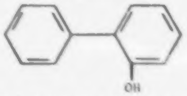
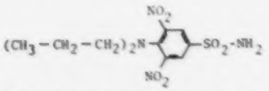
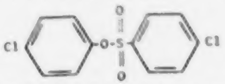
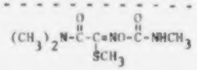
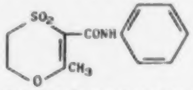
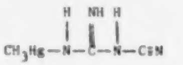
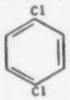
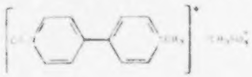
Common Name Chemical Name	Structural Formula	Description: Use	Formulation	Physical Form	Melting Point	Boiling Point	Solubility: Water	Hydrocarbons	Alcohols	Other	Stability: Heat	Light	Moisture	Other	Toxicity: Acute Oral LD_{50}	Acute Dermal LD_{50}	Environmental Concern: Persistence	Fish	Wildlife	Disposal Procedure: Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
MGK Repellent 11® 1,5a,6,9,9a,9b-Hexahydro-4a(4H)-dibenzofurancarboxaldehyde		R	[illegible]	L		307	insl	sol hyd							2,500					4	5	140
MGK Repellent 326® di-n-Propylisocinchomeronate		R	L F	L	[illegible]	150 1mm		pet oils	Et Op 1:Py ols						6,230	9.4 ml/kg				5	6,13	91
MGK Repellent 874® 2-(Octylthio)ethanol	$CH_3(CH_2)_7$-S-CH_2-CH_2OH	R	EC	L	[illegible]	98 .1 mm	sl.s.			org sls					8,530	skin	n	n	n	11,5	6	121
MH® 1,2-Dihydro-3,6-pyridazinedione		H Fum	wsp	S	292		6,000 ppm		Et 1,000 ppm	ace 1,000 xyl <1,000 ppm	dec 300				6,950		n			7	11	85
Milneb 3,3'-Ethylenebis(tetrahydro-4,6-dimethyl-2H-1,3,5-thiadiazine-2-thione		F		S	140		sl.s.				dec 140			dec solv	5,000		n			5	6,11	93
Mirex Dodecachlorooctahydro-1,3,4-metheno-1H-cyclobuta-[cd]pentalene		I	D	S	485		ins.		bz 12% xyl 14%						312	800 Rb		n	n	5	1-3	109
Mobam® 4-Benzothienyl N-methylcarbamate		I	wp d	S	128										234					7	1-3	76

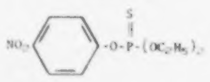
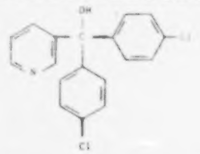
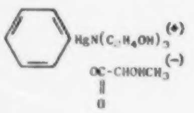
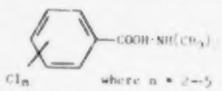
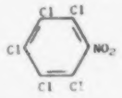
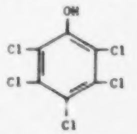
		Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
Common Name **Chemical Name**	Structural Formula	Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Molinate S-Ethyl hexahydro-1H-azepine-1-carbothioate		I H	ec g	L		202 1.0 mm	800 ppm			org mis					720					5	1-3 11	79
Monitor® O,S-Dimethyl phosphoramidothioate		I M	wsc	S	40		mis		mis						20	~50 mg/ kg				1-3	7	74
Monolinuron 3-(p-Chlorophenyl)-1-methoxy-1-methylurea		H	wp	S	76										2,250					5	11	87
Monuron 3-(p-Chlorophenyl)-1-dimethylurea		H	wp	S	174		230 ppm			ace 5.2% bz 0.3%	dec 190				3,600					5	6	87
Monuron TCA 3-(p-Chlorophenyl)-1,1-dimethylurea trichloroacetate		H	ec g	S			ins.				dec 90	dec s102 uv			3,000					5	6	87
Morestan® 6-Methyl-2-oxo-1,3-dithio-(4,5-b)quinoxaline		I M F	wp d	S	172		ins.		sl.s.	ace sl.s. bz- hot s.					3,000	skin 500 mg/kg LD_{50}				5	6	93
MPMT 2,4-Bis[(3-methoxypropyl)-amino]-6-methylthio-s-triazine		H	ec	S	55										1,400					1-3,5	6,7	89
MSMA Monosodium acid methanearsonate		H	wsc	L	O		s.								700		n			11	1-3	56

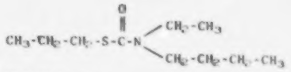
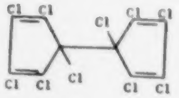
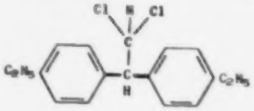
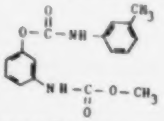
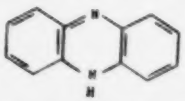
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Nabam Disodium ethylene-1,2-bisdithiocarbamate	 $\overset{S}{\parallel}$ $CH_2NHCSNa$ – $CH_2NHCSNa$ $\underset{S}{\parallel}$	F	c wp d	S	80		20%			org ins.	dec	dec	dec		395					8	1-3	83
Naled 1,2-Dibromo-2,2-dichloroethyl dimethylphosphate	 $(CH_3O)_2\overset{O}{\overset{\parallel}{P}}—O—\underset{H}{\overset{Br}{C}}—\underset{Cl}{\overset{Br}{C}}—Cl$	I H	ec d ulv	L	27	110 ,5 mm	ins			arom s.				ins alk	430			tox	n	1-3	7	65
Naphthalene		I	c	S	80	218	30 ppm		Et sl.s	org s.					2,200	skin		tox		4,5	11	130
Naphthalene acetamide 1-Naphthalene acetamide		PGR	wp	S	184		ins		Me 1.82 g Et 1.14 g/ 100g	ace sl.s.					1,000					11	7	86
Naphthalene acetic acid 1-Naphthalene acetic acid		PGR	L [illegible] wp	S	134		[illegible] g/100 g		[illegible]		dec uv				1,000					11,3	6	130
1,8-Naphthalic anhydride		PG	L	S											12,340					11	12	130
Naphthoxyacetic acid 2-Naphthoxyacetic acid		PGR		S	156		sl.s.		s.	ether s.										11	6,12	130
Naptalam N-1-Naphthylphthalamic acid		H	wp g	S	185		200 ppm		ace 5,000 ppm						>8,200				n	5	6	99

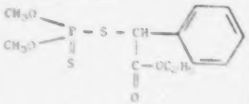
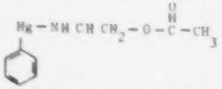
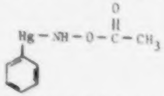
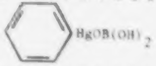
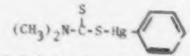
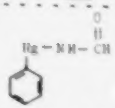
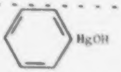
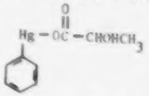
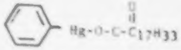
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Neburon 1-n-Butyl-3-(3,4-dichlorophenyl)-1-methylurea		H	wp	S	103		4.8 ppm	sl.s.							11,000					5	6	87
Nemacide O-2,4-Dichlorophenyl O,O-diethylphosphorothioate		N	ec g	L		122 .2mm	.245 ppm	ker mis		org mis					270					1-3	7	67
Neo-pynamin® 1-Cyclohexene-1,2-dicarboximidomethyl 2,2-dimethyl-3(2-methylpropenyl)cyclopropanecarboxylate		I	a ec d	S	~72	~188 .1mm			Et 4.5% w/w	ace 40% bz 50% w/w					>20,000					7	11	85
NIA-10637 Ethyl hydrogen 1-propylphosphate		PGR	c	L											2,300					7	1-4	65
Niacide® Mixture of manganous dimethyldithiocarbamate and mercaptobenzothiazole		F	s d wp	S	100						dec 100				1,500					8	1-3	83
Nicotine 3-(1-Methyl-2-pyrrolidyl) pyridine		I	ec	L	-80	247	mis		Et mis	org s.					50			tox	tox	1-3	5	91
Nitralin 4-(Methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline		H	wp ec	S	152		.6 ppm			ace 37% bz 12% w/w	dec 225				>2,000- >5,000	Rb >2,000				11	5	95
Nitrapyrin 2-Chloro-6-trichloromethyl pyridine		NI	ec	S	62-63	101 °C 1 mm	5.5	v.s.	m.s. 30g/ 100g 22°	tol 144g/ 100g 26° xyl 104g/ 100g 21°					1,000- 2,000 mg/kg	>2,000 mg/kg Rb	n			11	5	91

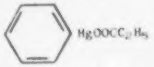
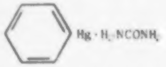
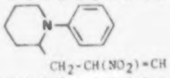
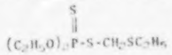
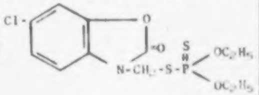
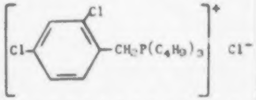
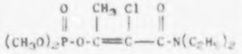
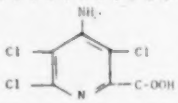
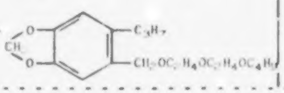
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Nitrobenzene		I	s	L	6	210	500 ppm		s.						700 Rb	skin				11	5	95
Nitrofen 2,4-Dichlorophenyl p-nitrophenyl ether		H	ec wp	S			ins.		Me 25%	ace kyl 25%					2,630					11	5	95
Norbormide 5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide		Ro	c a	S	>160		60 ppm		Et 1.4 mg/ ml					hyd alk	5.2 cat dog [illegible] >1,000					7	11	85
Norea 3-(Hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea		H	wp g	S	168		150 ppm	ker sl.s.	Et i-Pr s.	ace s.	dec slow 172				1,470	skin	>6 wk			5	6	87
n-Octanol	$CH_3(CH_2)_6CH_2OH$	I	ec	L	16.7	194	ins.	mis	mis				st							13	6,11 12	128
Orthodichlorobenzene o-Dichlorobenzene		Fu I	s a	L	-18	182	ins.		mis						500	skin				5	11	116
Ortho LM Methylmercury-8-hydroxyquinolate		F	c s	S											72					1-3	--	54

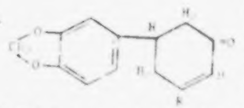
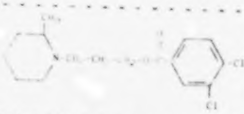
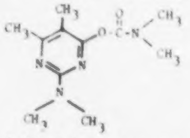
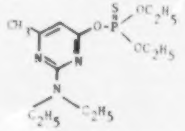
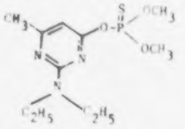
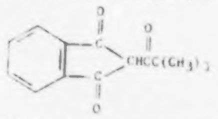
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Orthophenylphenol 2-Phenylphenol		F	wp s c	S	57	286	.07 g/100 g			org s.					2,480					4,6	11	130
Oryzalin 3,5-Dinitro-N^4,N^4-dipropylsulfanilamide		H		S	138		8.5 mg/100 ml		Et s.	ace s.					2,000					11	5	95
Ovex p-Chlorophenyl-p-chlorobenzenesulfonate		M	ec wp d	S	86		m.s.	pet m.s.	Et m.s.	ace s.					2,000				n	6,11	5	122
Oxamyl Methyl N',N',-dimethyl-N-[(methylcarbamoyl)oxy]-1-thiooxamimidate	 $(CH_3)_2N-\overset{O}{\overset{\|}{C}}-\underset{SCH_3}{C}=NO-\overset{O}{\overset{\|}{C}}-NHCH_3$	I		S	108-110															1-3	7	76
Oxycarboxin 5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide-4,4-dioxide		F	wp g	S	129		1,000 ppm		Et 3% Me 7% w/w	ace 36% bz 3.4% w/w					2,000					5	6	80
Panogen® Methylmercury dicyandiamide	 $CH_3Hg-\overset{H}{N}-\overset{NH}{\overset{\|}{C}}-\overset{H}{N}-C\equiv N$	F	wsc	S	156		2.17 g/100 ml		Et s.	ace s. bz ins.					45					1-3	--	54
Paradichlorobenzene p-Dichlorobenzene		Fu I F	c	S	53	173	80 ppm			org s.					500-5,000					5	4	116
Paraquat 1,1'-Dimethyl-4,4'-dipyridinium bis(methyl sulfate)		H	c	S			s.				dec	dec some uv			150		n			11	5,13	98

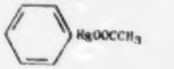
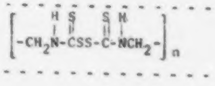
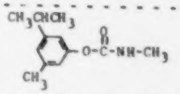
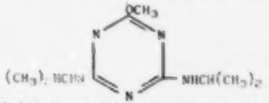
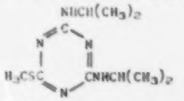
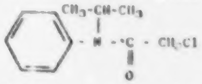
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Parathion O,O-Diethyl-O-p-nitrophenylphosphorothioate		I M	wp ec d g	L	6	160 .6 mm 375 760 mm	24 ppm	pet sl.s.		org mis				hyd by alk	13	skin	4-6 wk			1-3	7	67
Parinol α,α-Bis(p-chlorophenyl)3-pyridinemethanol		F	ec	S	170		low	ins.	Et s.	ace s.				st acd alk	5,000					5	1-3	119
Paris Green Copper meta-arsenite, copper acetate complex	$(CH_3COO)_2Ca\cdot 3Cu(AsO_2)_2$	I	wsc	S											22				tox	11	1-3	56
PAS Phenylmercurictriethanolammonium lactate		F	s.	S	126		s.								30					1-3	--	94
PBA Dimethylamine salt of polychlorobenzoic acid	 where n = 2--5	H	ec	S			s.								1,140					5	1-3	117
PCNB Pentachloronitrobenzene		F	ec wp d g	S	144	328	ins.		Et s.	ace xyl s.					>12,000					1-3	5	95
PCP Pentachlorophenol		F H Mo	c wsc wp ec	S	~180	310	.003 g/100 g		Et v.s. Me 180g/ 100g		dec 309				27-80					5	1-3	117

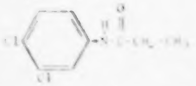
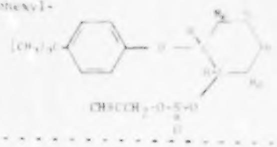
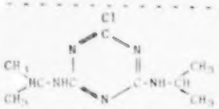
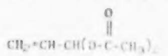
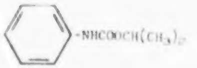
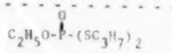
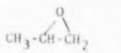
Common Name **Chemical Name**	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Pebulate S-Propyl butylethylthiocarbamate	 $CH_3\text{-}CH_2\text{-}CH_2\text{-}S\text{-}\overset{O}{\overset{\Vert}{C}}\text{-}N(CH_2\text{-}CH_3)(CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3)$	H	ec g	L		142 21 mm	60 ppm	ker mis	Et mis	acp mis					1,280					5	1-3 11	79
Penar® Dimethyldodecylammonium acetate	$C_{12}H_{25}\text{-}\overset{+}{N}(H)(CH_3)_2CH_3\overset{-}{COO}$	PGR	ec	L	-18	104									800- 1,580					11	5,13	98
Pentac® **Bis(pentachloro-2,4-cyclopentadien-1-yl)**		H	ec wp	S	122		ins				dec 250				>3,160					5	1-3	109
Perthane® 1,1-Dichloro-2,2-bis-(4-ethylphenyl)ethane		I	ec wp d	S	60		ins			arom s.	dec >52				8,170					5	7	105
Petroleum oils		I		L		280- 370									10,000			tox		11	6 12	130
Phenmedipham **Methyl m-hydroxycarbanilate m-methylcarbanilate**		H	ec	S	144		<.001 g/100 ml	Me 5 g/ 100 ml		ace 20 bz .25 g/100 ml					>7,800					7	1-3	76
Phenothiazine Dibenzo-1,4-thiazine		I	d wp	S	185	371	ins		sl.s.	bz s.					5,000					5	6 11	93

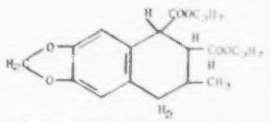
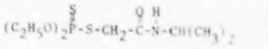
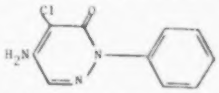
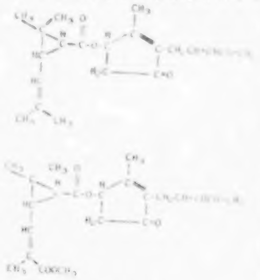
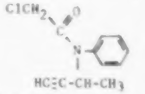
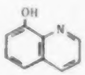
Common Name Chemical Name	Structural Formula	Description: Use	Description: Formulations	Description: Physical Form	Description: Melting Point	Description: Boiling Point	Solubility: Water	Solubility: Hydrocarbons	Solubility: Alcohols	Solubility: Other	Stability: Heat	Stability: Light	Stability: Moisture	Stability: Other	Toxicity: Acute Oral LD50	Toxicity: Acute Dermal LD50	Environmental Comment: Persistence	Environmental Comment: Fish	Environmental Comment: Wildlife	Disposal Procedure: Preferred Procedure No.	Disposal Procedure: Alternate Procedure No.	Disposal Procedure: Additional Information Page No.
Phenthoate S-[α-(Ethoxycarbonyl)benzyl] O,O-dimethyl phosphorodithioate		I M		S	18		11 ppm			org mis					250- 300					1-3	7	71
2-(Phenylmercuriamino)-ethyl acetate		F																		1-3	--	54
Phenylmercuric ammonium acetate		F																		1-3	--	54
Phenylmercuric borate		F		S	130		s.													1-3	--	54
Phenylmercuric Dimethyldithiocarbamate		F																		1-3	--	54
N-Phenylmercuric formamide		F																		1-3	--	54
Phenylmercuric hydroxide		F		S	200		s.		s.	org sl.s.	dec 200									1-3	--	54
Phenylmercuric lactate		F																		1-3	--	54
Phenylmercuric naphthenate		F																		1-3	--	54
Phenylmercuric oleate		F																		1-3	--	54

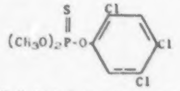
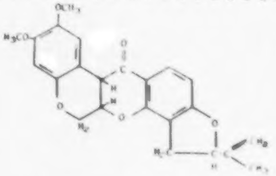
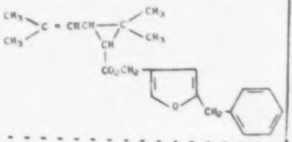
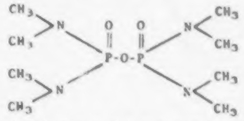
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Phenylmercuric propionate		F		L																1-3	--	54
Phenylmercury urea		F	d	S																1-3	--	54
N-Phenyl-2-nitropropyl piperidine		I																		5,13	11	95
Phorate O,O-Diethyl S-(ethylthio)-methyl phosphorodithioate	 $(C_2H_5O)_2\overset{S}{\overset{\parallel}{P}}-S-CH_2SC_2H_5$	I	ec g	L	-15	119 .8mm	50 ppm			xyl mis					3.7	skin		tox		1-3	7	71
Phosalone O,O-Diethyl S-[(6-chloro-2-oxo benzoxazolin-3-ylmethyl] phosphorodithioate		I	ec	S	45		ins.		Et Me s.	ace bz xyl s.					120					1-3	7	71
Phosfon® Tributyl 2,4-dichlorobenzyl phosphonium chloride		PGR	d wsc	S	~124		s.	ker ins.	Et i-Pr s.	ace bz s.					178		per		n	1-3	11	75
Phosphamidon 2-Chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate	 $(CH_3O)_2\overset{O}{\overset{\parallel}{P}}-O-\overset{CH_3}{\overset{\vert}{C}}=\overset{Cl}{\overset{\vert}{C}}-\overset{O}{\overset{\parallel}{C}}-N(C_2H_5)_2$	I M	wp d c	L		162 1.5 mm	mis	ker ins.	s.	ace s.					28.3		n	tox 1,000 ppm		1-3	7	65
Picloram 4-Amino-3,5,6-trichloro-picolinic acid		H	wsc	S			.043 ppm	ker <10 ppm		ace 1.99 g/ 100 ml	dec 215				8,200		per		n	5	1-3	91
Piperonyl butoxide α-[2-(2-Butoxyethoxy)-ethoxy]4,5-methylenedioxy-2-propyltoluene		Syn	d wp a	L		180 1mm				ace bz s.					7,500	skin Rb 200 mg/ kg			n	11	6	125

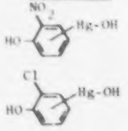
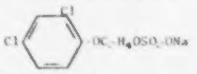
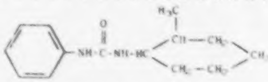
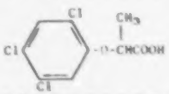
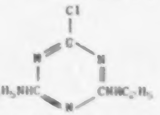
Common Name Chemical Name	Structural Formula	Description: Use	Description: Formulations	Description: Physical Form	Description: Melting Point	Description: Boiling Point	Solubility: Water	Solubility: Hydrocarbons	Solubility: Alcohols	Solubility: Other	Stability: Heat	Stability: Light	Stability: Moisture	Stability: Other	Toxicity: Acute Oral LD_{50}	Toxicity: Acute Dermal LD_{50}	Environmental Comment: Persistence	Environmental Comment: Fish	Environmental Comment: Wildlife	Disposal Procedure: Preferred Procedure No.	Disposal Procedure: Alternate Procedure No.	Disposal Procedure: Additional Information Page No.
Piperonyl cyclonene Mixture of 3-alkyl-6-carbethoxy-5-(3,4-methylenedioxyphenyl)-2-cyclohexene-1-one and 3-alkyl-5-(3,4-methylenedioxyphenyl)-2-cyclohexene-1-one		syn		1		180	ins.								5,200				m	11	6,7	125
Pipron[S] 3-(2-Methylpiperidino)propyl 3,4-dichlorobenzoate		F	wp ec	L		156 .2 mm	sl.s.	s.							2,529			tox		5	6,11	91
Pirimicarb 2-(Dimethylamino)-5,6-dimethyl-4-pyrimidinyl dimethylcarbamate		I	wp	S	90.5		0.27 g/ ml	s.							147	>500				1-3	7	76
Pirimiphos ethyl O-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] diethyl phosphorothioate		I	ec g	L			>1 ppm	mis							140- 200	1,000- 2,000				1-3	7	67
Pirimiphos methyl O-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] O,O-dimethyl phosphorothionate		I	d ec	L											2,000 mg/kg	>2,000 mg/kg				7	1-3	67
Pival 2-Pivaloylindane-1,3-dione		Ro	b	S			18 ppm								15- 35			tox	tox	4,5	4,11	132

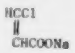
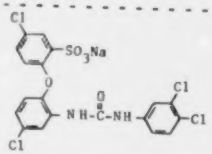
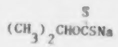
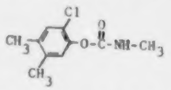
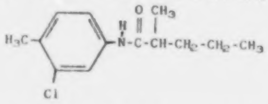
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
PMA Phenylmercuric acetate		F H	wsc	S	151		.437 g/100 ml		Et s.	ace bz s.					40- 50					1-3	--	54
Polyacrylonitrile, hydrolyzed sodium salt	NA	F																		11	12	99
Polyethylene polysulfide	NA	F	*l*																	11	5	123
Polyethylene thiuram disulfide	 $\left[-CH_2\overset{H}{N}-\overset{S}{C}SS-\overset{S}{C}-\overset{H}{N}CH_2-\right]_n$	F																		11	5	80
Polyram® Mixture of 5.2 parts by weight (83.9%) of ammoniates of [ethylene-bis-(dithiocarbamate)]zinc with 1 part by weight (16.1%) ethylenebis[dithiocarbamic acid], bimolecular and trimolecular cyclic anhydrosulfides and disulfides		F	s d wp	S			ins.				dec begins 140				6,200					8	1-4	80
Promecarb m-Cum-5-yl-methylcarbamate		I	ec wp d	S	88	117 .01 mm	92 ppm								35- 248					7	1-3	76
Prometone 2,4-Bis(isopropylamino)-6-methoxy-s-triazine		H	ec wp	S	92		750 ppm					dec uv			2,980					1-5	6,7	89
Prometryne 2,4-Bis(isopropylamino)-6-(methylthio)-s-triazine		H	wp	S	119		48 ppm					dec uv			3,750		3-10 wk			1-5	6,7	89
Propachlor 2-Chloro-N-isopropylacetanilide		H	wp g	S	72	110 .03 mm	700 ppm w			ace 31% bz 50%	dec 170				1,200					1-3	5	80

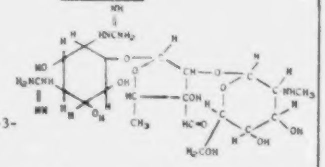
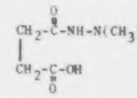
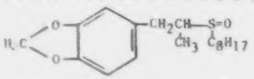
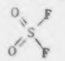
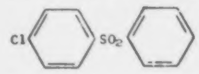
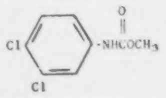
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.'	Additional Information Page No.
Propanil 3',4'-Dichloropropionanilide		H	ec	S	87		0.5%		150 s.	xyl s.					1,384		n			5	1-3	80
Propargite 2-(p-tert-Butylphenoxy)cyclohexyl-2'-propynyl sulfite		M		o			ins.								2,500					5	6,11	122
Propargyl bromide 3-Bromo-1-propyne	$HC{\equiv}C{-}CH_2Br$	Fu		L		98									1,384- 2,270					5	6	115
Propazine 2-(Chloro-4,6-bis-(isopropylamino)-s-triazine		H	wp	S	213		8.6 ppm					Some dec uv		hyd acd alk	>5,000		per			1-5	6,7	89
2-Propene-1,1-diol diacetate Diacetoxypropene	 $CH_2{=}CH{-}CH(O{-}\overset{O}{\overset{\Vert}{C}}{-}CH_3)_2$	F		L		107 50 mm	1.8%			org s.					250					6	11	128
Propham Isopropyl N-phenylcarbamate		H	ec wp d c a	S	88		250 ppm		eth iso v.s.	ace v.s.	dec above 150				4,500- 9,000					7	11	76
Prophos O-Ethyl S,S-dipropyl phosphorodithioate	 $C_2H_5O{-}\overset{O}{\overset{\Vert}{P}}{-}(SC_3H_7)_2$	I N	a ec g	L	88 .2 mm	750 ppm				org s.					6.5					1-3	7	71
Propionic acid	CH_3CH_2COOH	F	l	L	-21	144	mis		mis		st		st				n			13	11,12	128
Propylene oxide		Fu		L		34	40%		mis						3,000					14	12	128

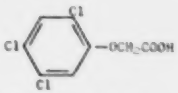
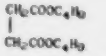
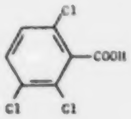
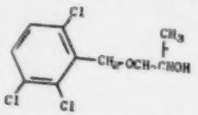
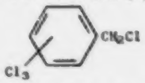
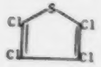
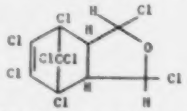
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Propyl isome Di-n-propyl 6,7-methylenedioxy-3-methyl-1,2,3,4-tetrahydronaphthalene-1,2-dicarboxylate		Syn		l		~220 1mm	ins.	arom s. s.	s.					hyd alk	15,000					6	11	125
Prothoate O,O-Diethyl-S-(N-isopropylcarbamoylmethyl)-phosphorodithioate	 $(C_2H_5O)_2\overset{S}{P}-S-CH_2-\overset{O}{C}-\overset{H}{N}-CH(CH_3)_2$	I M		S	28		.25%			org s.				dec alk						1-3	7	71
Pyrazon 5-Amino-4-chloro-2-phenyl-3(2H)-pyridazinone		H	wp	S	207		.03 g/ 100 g		Me 3.5 g/ 100 g		dec at mp			dec alk	3,000					5	6,11	91
Pyrethrins Mixture of pyrethrum I and II, cinerins I and II and related compounds		I	a a d ec					s.				un- stable to sun- light			1,500- 2,600		n	n	n	11	6,12	125
Prynachlor 2-Chloro-N-(1-methyl-2-propynyl)acetanilide		H		S	45				Et 16g /100 ml	ace 120 g/ 100 ml				hyd acd alk	1,177					5	6	83
8-Quinolinol 8-Hydroxyquinoline (disposal information applies to 8-quinolinol salts also)		F		S	76		s.		eth sl.s.						1,200					5	11	91

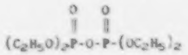
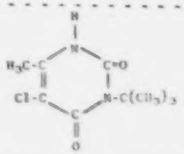
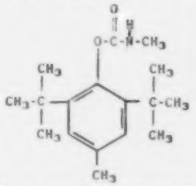
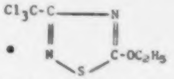
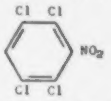
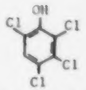
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Red Squill Extract of the bulbs of *Urginea maritima* (*Scilla maritima*)	Indeterminate	Ro	p	S							detox above 80%				200-3,000					11	7,5	125
Ronnel O,O-Dimethyl-O-(2,4,5-trichlorophenyl)phosphorothioate		I	wp ec g	S	41		40 ppm	ker s.		org s.					1,740					1-3	7	67
Rotenone From roots of *Derris elliplica*		I	ec d wp	S	163		15 ppm	sl.s.							132-1,500			v tox		7	5,6	125
Ryania Ground stems of *Ryania speciosa*		I	d	S	220		s.			bz sl.s.					750-1,000					7	5,6	125
Sabadilla From *Schoenocaulum officinale*		I	ec wp	S	147		555 ppm			org s.					4,000					5	6,13	125
SBP 1382 (5-Benzyl-3-furyl-methyl-2,2-dimethyl-3-(2-methylpropenyl)-cyclopropanecarboxylate		I	s ec a	S	43-48		ins.			org s.		dec			2,000					12	6,11	125
Schradan Octamethylpyrophosphoramide		I	ec	L	17	120 .3 mm	mis	pet sl.s.		org s.				dec acd	9.1					1-3	8	74

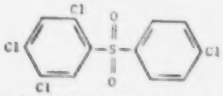
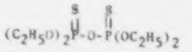
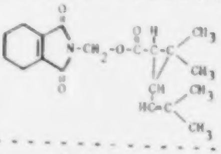
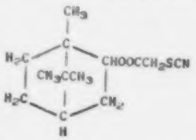
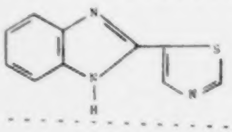
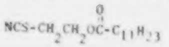
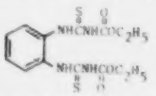
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Semesan Bel® Hydroxy mercurichlorophenol and hydroxy mercurinitrophenol mixture		F	a c	S						p										1-3	--	54
Sesone Sodium 2-(2,4-dichlorophenoxy)ethyl sulfate		H	wsc	S	245		25%				dec above 245			hyd alk	730-1,400					5	7,12	107
Siduron 1-(2-Methylcyclohexyl)-3-phenylurea		H	wp	S	136		18 ppm		Et 160,000 ppm						>5,000					5	6	87
Silica Gel Treated silicon dioxide	SiO_2	I	d	S			ins.			org ins.					3,160					12	11	62
Silvex 2-(2,4,5-Trichlorophenoxy)-propionic acid		H	ec wsc	S	178		.018 g/100 g		Me 12 g/100 g	ace 17 g/100 g					650					5	7,12	107
Simazine 2-Chloro-4,6-bis(ethylamino)-s-triazine		H	wp g sp	S	226		5 ppm		Me 400 ppm			dec uv			>5,000					1-5	6,7	81
Sodium arsenate	$Na_2HAsO_4 \cdot 7H_2O$	I H		S			s.		sl.s.								per	tox	tox	11	1-3	56
Sodium arsenite	$NaAsO_2$	H I	c	S			s.		sl.s.						10-50		per	tox	tox	11	1-3	56
Sodium chlorate	$NaClO_3$	H	g p	S	248	dec	79 g/100 ml		s.		dec				5,000			tox		11,13	10	62

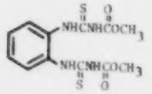
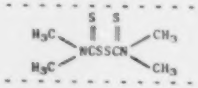
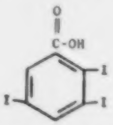
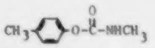
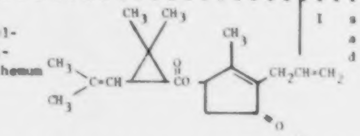
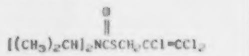
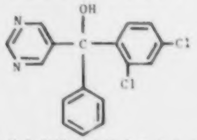
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Sodium cis-3-chloroacrylate **cis-3-chloropropenoic acid, sodium salt**	 $\begin{array}{l}HCCl\\ \|\\ CHCOONa\end{array}$	H		S	162	dec	40%				dec				320	400 mg/kg				12	13	112
Sodium 5-chloro-2-[4-chloro-2-[3-(3,4-dichlorophenyl)ureido]-phenoxy] benzenesulfonate		I		S			.05%								750- 1,380					5	6	87
Sodium fluoride	NaF	I		S	980	1,700	4.2 g/100 g		Et sl.s.						200					7 lime	11	62
Sodium fluoroacetate	$CH_2FCOONa$	Ro	b	S			v.s.				dec 200°				.22			v tox	v tox	1-3	--	128
Sodium fluosilicate **Sodium fluosilicate**	Na_2SiF_6	I R	d b	S	dec		0.65 g/ℓ 17°		ins.		dec				125		pp			11	1-3	62
Sodium isopropyl xanthate	 $(CH_3)_2CHO\overset{S}{C}SNa$	H		S							dec 150°									8	11	122
Sodium metaborate tetrahydrate	$Na_2B_2O_4 \cdot 4H_2O$			S	>57		v.s.	ins.			$-H_2O$ 120°				2,330					11	4,13	62
Sok® 6(and 2)-Chloro-3,4-xylyl N-methylcarbamate		M I																		7	1-3	76
Solan® 3'-Chloro-2-methyl-p-valerotoluidide		H		S	84		ins.				xyl 30%				>10,000		>6 mo	n		5	1-3	83
Sorbic acid	$CH_3CH_2CHCHCHCOOH$	E	c	133	228		sl.s.		sl.s.											11	5	128

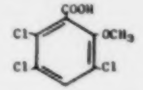
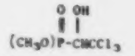
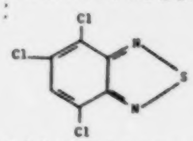
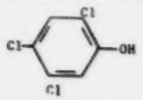
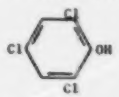
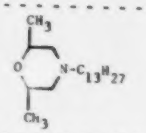
		Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
Common Name Chemical Name	Structural Formula	Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Streptomycin 2,4-Diguanidino-3,5,6-trihydroxy-cyclohexyl-5-deoxy-2-O-(2-deoxy-2-methyl-amino-α-L-glucopyranosyl-3-formyl-pentanofuranoside			wp	S											300					5	11	125
Strobane® Terpene polychlorinates (65-66% chlorine)		I	ec wp d	L			ins.		s.						250					5	1-3	109
Strychnine Alkaloids of *S. vomica*		Ro	b	S		275n	sl.s.		sl.s.		dec 275				1-30			v tox	v tox	1-3	5	125
Succinic acid dimethylhydrazide Succinic acid 2,2-dimethyl-hydrazide	 $CH_2-\overset{O}{\overset{\|}{C}}-NH-N(CH_3)_2$ / $CH_2-\underset{O}{\underset{\|}{C}}-OH$	PGR	wsc	S		155	sl.s.								8,400					7	11	85
Sulfoxide 1,2-Methylenedioxy-4-[2-octylsulfinylpropyl]benzene		Syn	s a	L		dec	ins.		org mis	dec					2,000- 2,500					11,5	6	121
Sulfur	S_x	Fu I	p	S	115	445	ins.		Et sl.s									n	n	11	12	62
Sulfuryl fluoride		Fu I	c	G		-55 760 mm	.075 g/100 g							dec alk						1-3	14	123
Sulphenone p-Chlorophenyl phenyl sulfone		M	ec wp	S	92		ins.	pet sl.s.							1,400					5	11	121
Swep Methyl 3,4-dichloro-carbanilate		H		S	113		ins.	ker ins.		ace 46%					522					1-3	5	76

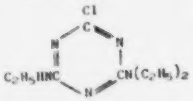
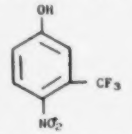
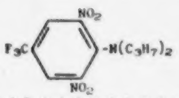
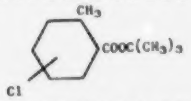
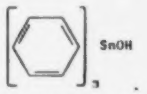
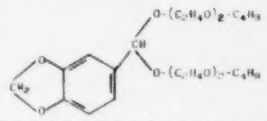
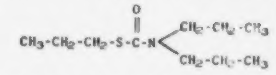
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
2,4,5-T 2,4,5-Trichlorophenoxyacetic acid (Disposal information applies to 2,4,5-T derivatives also)		H	ec wsc	S	154		238 ppm		Et 1-Pr 590 ppm						300					5	7	107
Tabutrex® Di-N-butyl succinate	 $CH_2COOC_4H_9$ $\vert$ $CH_2COOC_4H_9$	R	ec s	L	-29	108 4mm	ins.			org mis					8,000					11	6,12	130
2,3,6-TBA 2,3,6-Trichlorobenzoic acid		H	g s	S	126		.84 g/100 ml		Et 64 Me 72 g/ 100 ml	ace 60.7 bz 24 xyl 21 g/ 100 ml					750- 1,000					5	1-3	117
TBP 2,3,6-Trichlorobenzyloxypropanol		H	w	S		122 .1 mm									3,160					5	1-3	117
TCA Trichloroacetic acid	Cl_3CCOOH	H	wsc g	S	59	198	1,306 g/100 g		Me 2,143 g/100 g	ace 850 g/ 100 g					5,000					5	7	112
TCBC Trichlorobenzyl chloride		H	wsc g	L		96 1mm	2 ppm				dec 90				3,075					5	1-3	117
TCTP Tetrachlorothiophene		N	ec	S	29										780					5	1-3	119
Telodrin® Isobenzan		I		S	120		ins.	ker al.s.		ace bz xyl s.					5	skin v tox	per	tox	tox	1-3	5	109

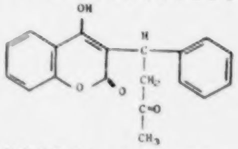
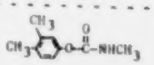
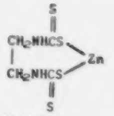
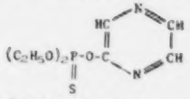
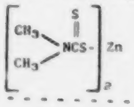
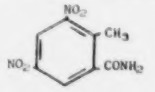
Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
TEPP O,O,O',O'-Tetraethyl pyrophosphate	 $(C_2H_5O)_2\overset{O}{\overset{\Vert}{P}}\text{-O-}\overset{O}{\overset{\Vert}{P}}\text{-}(OC_2H_5)_2$	M I	ec c	L		124 1mm	mis	pet sl.s.				hdl			1.2-2.0	skin		tox	tox	1-3	7	65
Terbacil 3-tert-Butyl-5-chloro-methyluracil		H	wp	S	176		.710 ppm			xyl 61,000 ppm					5,000- 7,500					5	6	87
Terbutol 2,6-Di-t-butyl-4-methylphenyl N-methylcarbamate		H	wp g	S	200		6 ppm	ker ins.	Et s.	ace s. bz sl.s.					>34,600					7	1-3	76
Terrazole® 5-Ethoxy-3-trichloromethyl-1,2,4-thiadiazole		F	ec d g wp	L	20	95 1mm	ins.		Et s.	ace xyl s.					mice 2,000					5	11	93
Tetrachloroethylene Perchloroethylene	$Cl_2C{=}CCl_2$	Fu		L		121	ins.			org mis					2,200					5	12	112
Tetrachloronitrobenzene 1,2,4,5-Tetrachloro-3-nitrobenzene		F	g	S	99		m.s.		s.	bz s.					low					1-3	5,11	95
2,3,4,6-Tetrachlorophenol		F			69	dec	ins.		v.s.	s. alk	dec 150									5	1-3	117

Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Tetradifon p-Chlorophenyl 2,4,5-trichlorophenyl sulfone		M	ec wp	S	148		.02 g/ 100g	pet ins.		ace xyl s.		st uv			>14,700			n	n	5	1-3 11	117
Tetraethyl dithiopyrophosphate O,O,O',O'-Tetraethyl dithiopyrophosphate	 $(C_2H_5O)_2\overset{S}{\overset{\|}{P}}-O-\overset{S}{\overset{\|}{P}}(OC_2H_5)_2$	M I	a	L	>-10	138 2mm									5	skin		tox	tox	1-3	7	67
Tetramethrin (1-Cyclohexene-1,2-dicarboximido)methyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate		I	-	S	65- 80			m.s.	sl.s.						>20,000 mg/kg	>15,000 mg/kg				13	6,11 12	125
Thallium sulfate	Tl_2SO_4	Ro I	b	S	632		5g/ 100 cc				dec 632				25		per	tox	tox	1-3	11	59
Thanite® Isobornyl thiocyanoacetate		I	ec wp d a	L			ins.		v.s.						1,600					9	6	123
Thiabendazole 2-(4-Thiazolyl)benzimidazole		F	wp	S	304	sub 310	sl.s.								3,330					5	1-3	93
2-Thiocyanoethyl laurate	 $NCS-CH_2CH_2O\overset{O}{\overset{\|}{C}}-C_{11}H_{23}$	I																		6	9	123
Thiophanate® Diethyl 4,4'-o-Phenylenebis(3-thioallophanate)		F	wp	S	dec at 193		ins.	ins.	s.s.		st to 160	st		dec at pH >7	>15,000 mg/kg	>15,000 mg/kg				11	12,13	99

Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Thiophanate Methyl® Dimethyl 4,4'-o-phenylene-bis(3-thioallophanate)		F	wp	S	dec at 178		ins.	m.s.	sl.s.		st to 160			dec at pH >7.0	>6,600 mg/kg	>10,000 mg/kg				11	12,13	99
Thiram Tetramethylthiuram disulfide		F R	wp d	S	156		ins.			bz s.					1,400					8	1-4	80
TIBA 2,3,5-Triidobenzoic acid		PGR	ec	S			ins.		s.	ace bz					700					5	1-3	117
m-Tolyl N-methylcarbamate		I																		7	1-3	76
Toxaphene Mixture of chlorinated camphenes containing 67-69% chlorine	$\sim C_{10}H_{10}Cl_8$	I	ec wp d g b	S	~84		3 ppm	pet s.		org s.	de-HCl	de-HCl		de-HCl iron	80-90			v tox		5	1-3	109
D-Trans Allethrin® DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with D-trans chrysanthemum monocarboxylic acid		I	s a d	L			ins.		eth me mis	ace bz mis					920					11	6,12	125
Triallate S-(2,3,3-Trichloroallyl)-diisopropylthiocarbamate	 $[(CH_3)_2CH]_2NC(=O)SCH_2CCl{=}CCl_2$	H	ec g	L	30	148 9mm	4 ppm		eth s.	ace s.					2,165				n	5	1-3 11	79
Triarimol α-(2,4-Dichlorophenyl-α-phenyl-5-pyrimidinemethanol		F																		5	1-3 11	91

Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Tricamba 3,5,6-Trichloro-o-anisic acid		F	wsc	S	138		ins.		eth v.s.	xyl m.s.					970					5	1-3	117
Trichlorfon Dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate	 $(CH_3O)\overset{O}{\overset{\Vert}{P}}-\overset{OH}{\overset{\vert}{C}}HCCl_3$	I	wp s ec sp G B	S	82	100 .1mm	10%		s.						450- 500					1-3	7	65
4,5,7-Trichlorobenzthiadiazole		H		S	132		2.5 ppm		me 3%	ace 3% bz 10%					1,620					5	11	93
1,1,1-Trichloroethane	CCl_3CH_3	Fu		L	-31	74	ins.		mis						750					14	12	112
2,4,5-Trichlorophenol		F		S	67	sub	ins.		v.s.	org s.										5	11	117
2,4,6-Trichlorophenol		F		S	69	248	ins.		v.s.	org s.					820					5	11	117
Tridemorph 2,6-Dimethyl-4-tridecyl-morpholine		F	l												650					11	5,6	99

Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Trietazine 2-Chloro-4-diethylamino-6-ethylamino-s-triazine		H		S	102		20 ppm	sl.s.	Me 1.9%	org s.			st	st acd alk	3,800					1-5	6,7	89
3-Trifluoromethyl-4-nitrophenol		La		S											500-1,000					5	11	95
Trifluralin α,α,α-Trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine		H	g c	S	49	96 .18 mm	<1 ppm			ace xyl s.		dec uv			>10,000			tox		11	5	95
Trimedlure tert-Butyl 4(or5)-chloro-2-methylcyclohexane carboxylate		A		L		90 .6 mm	ins.			org s.					low					11	6,12	130
Triphenyltin hydroxide		F	wp	S	119		ins.			org m.s.					108					1-3	11	59
Tropital® Piperonal bis[2-(2'-n-butoxyethoxy)ethyl] acetal		Syn	wp	L		195 0.22 mm	ins.	mis	mis		dec				4,000					12	7,8	125
Vernolate S-Propyldipropylthiocarbamate		H	ec g	L		150 30 mm	90 ppm	ker mis	xyl mis						1,780					5	1-3 11	79

Common Name Chemical Name	Structural Formula	Description					Solubility				Stability				Toxicity		Environmental Comment			Disposal Procedure		
		Use	Formulations	Physical Form	Melting Point	Boiling Point	Water	Hydrocarbons	Alcohols	Other	Heat	Light	Moisture	Other	Acute Oral LD_{50}	Acute Dermal LD_{50}	Persistence	Fish	Wildlife	Preferred Procedure No.	Alternate Procedure No.	Additional Information Page No.
Vorlex® Methyl isothiocyanate	$CH_3-N=C=S$	F Fu V	ec	S	35	119	.76%		Et me s.	acp bz s.				dec n soil 3 wk	360					11	12	99
Warfarin 3-(α-Acetonylbenzyl)-4-hydroxycoumarin		Ro	b c	S	162		ins.		m.s.	ace s.					58- 323			tox		5	4,11	132
3,4-Xylyl N-methylcarbamate		I													320					7	1-3	76
Zinc phosphide	Zn_3P_2	Ro	b	S	~420		ins.		ins.				dec slow		75.7					11	1-3	60
Zineb Zinc ethylene bisdithiocarbamate		F	wp d	S	dec						dec				>5,000			n		8	1-4	83
Zinophos® O,O-Diethyl O-(2-pyrazinyl) phosphorothioate		I N	ec g	L	-2		1,140 ppm			org mis				hyd alk	12		n			1-3	7	67
Ziram Zinc dimethyldithiocarbamate		F R	wp	S	256		ins.							dec acd	1,400		n			8	1-4	83
Zoalene 3,5-Dinitro-o-toluamide		I		S	180		sl.s. <1%	ker s.	Et s.	ace s.				st acd dec alk	600					11	5	95

SECTION XII

POTENTIAL DISPOSAL PROCEDURES AVAILABLE TO THE LAYMAN

Directions and methods are given in this section of the manual which local EPA officials, public health officials, county agents, or other responsible authorities can use in their efforts to aid the layman in solving his specific pesticide disposal problems.

Upon receiving an inquiry, an official must first carefully determine exactly what the disposal problem is before recommending any course of action. To do this, he must determine what specific pesticide, pesticide concentration, and type of formulation are involved. (This information is available on the container label and its ingredients statement.) He must also determine how much pesticide is involved. Once the disposal problem has been defined, he can, by referring to Section V of this report, determine what procedure in this section is normally appropriate and, by referring to Sections VI, VII, and XI, determine if special problems are involved or special precautions are necessary. He can then recommend a specific method for dealing with the problem, based on a knowledge of local conditions, regulations, available services, and a good measure of common sense. He can give the layman a copy of a specific procedure from this section as a guide. Preferably, however, he will amend and tailor the procedure to the type and actual amount of pesticide involved in each particular case.

This section contains 14 procedures that might be used by a layman for the disposal of unwanted pesticides. In addition, separate procedures are described for disposing of empty containers, and for handling pesticide spills. The procedures are listed in Table 12.

The specific techniques for unwanted pesticides fall into two size categories. Procedures 1 through 3 can be used for large volumes of unwanted material. Procedures 4 through 14 are applicable only to small quantities of material: generally less than 50 lb or 5 gal., but possibly less if an extremely toxic material is involved. These disposal techniques can also be grouped according to the approach used: Procedures 1 through 5 involve the removal of the unwanted material to sites properly equipped for its disposal; Procedures 5 through 10 involve the conversion of the pesticide into a less objectionable form; and Procedures 11 through 14, involve the controlled release of certain nonpersistent pesticides to the environment.

TABLE 12

LIST OF DISPOSAL PROCEDURES

Pesticide Disposal Procedure No.	Description	Page
1	Turn in to pesticide collection center. . . .	303
2	Return to supplier.	306
3	Turn in to industrial waste service	307
4	Place in trash for pick-up service.	308
5	Incineration.	309
6	Burning	310
7	Treatment with alkali	311
8	Treatment with acid	313
9	Treatment with oxidants	315
10	Treatment with reducing agents.	317
11	Burial in the ground.	319
12	Ground surface disposal	320
13	Dilution.	321
14	Release to the air.	322
Disposal of containers.		323
Cleanup and treatment of spills		326

General Information and Examples

Procedures 1 through 3: These three procedures represent the minimum risk to the layman. The status of the services required is, however, very much in flux, and a complete description of their availability in different parts of the country cannot be given here. Addresses and telephone numbers of the 12 regional EPA offices are listed in Procedure No. 1, together with the names of other potential local sources of information. The addresses and telephone numbers of major pesticide manufacturers, which may be needed in Procedure No. 2, are listed in Part I, Appendix A. Note that the manufacturer named on the label of the pesticide container is not necessarily the basic manufacturer of the "active ingredient": the one named is often the formulator (see Section V). The basic manufacturers of many major pesticides are listed in Appendix B. Suggestions for locating a local waste disposal service that handles pesticides are given in Procedure No. 3.

Information on the packaging and shipping of hazardous materials, including pesticides, is given in the Code of Federal Regulations, Title 49, Parts 170-180. It is available from the:

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

at a cost of $5.75 per copy. Alternatively, one of the following tariffs, which reproduces the Hazardous Materials Regulations of the Code can be used:

R.M. Graziano's Tariff No. 25
Bureau of Explosives
Association of American Railroads
1920 L Street, N.W.
Washington, D.C. 20036
($15.00 per copy)

ATA Dangerous Articles Tariff No. 14
American Trucking Associations
1616 P Street, N.W.
Washington, D.C. 20036
($11.00 per copy)

Examples of pesticides for which Disposal Procedures 1, 2 or 3 are preferred include:

Alicarb
Dieldrin
Mercury Compounds
Nicotine
Parathion
TEPP
Sodium fluoroacetate
Thallium sulfate

Procedure 4: The use of a municipal or other service that picks up household solid wastes (trash) for the disposal of pesticides is limited in application to small amounts of certain pesticides or dilute pesticide formulations which are of little hazard. This procedure has been listed as a preferred or copreferred method for only a few pesticides, and is listed as an alternate method for a few others. This procedure might also be considered in specific cases for nearly nonhazardous formulations of pesticides for which it is not listed in Section XI. Examples of such pesticides or formulations would include many of those which are used within the home by the homeowner, and very small quantities (a few ounces) of certain other pesticide formulations of low toxicity and hazards.

Procedures 5 and 6: These two procedures employ combustion. Nearly all pesticides are decomposed by combustion at elevated temperatures, but not all pesticide formulations are suitable for disposal by these procedures, e.g., clay-based products. Rather sophisticated all-purpose incineration equipment is required in many cases, and this equipment would generally not be available to the layman. In some areas open burning is permitted and, in a few cases, this appears to be the best method when one considers the total environmental and safety picture.

Examples of pesticides which should be disposed by incineration (Procedure No. 5) include the persistent or multichlorinated hydrocarbons such as DDT, 2,4,5-T, etc. Simple burning of the pesticide by the layman (Procedure No. 6) can be recommended as the preferred method for only a few pesticides--generally those which do not contain metals, phosphorus, chlorine, or bromine, and have little or no nitrogen or sulfur in the molecule. Those which contain primarily carbon and hydrogen (oxygen is also permitted) are candidates.

Procedures 6 through 10: These four procedures employ chemical detoxifying techniques. The active ingredient in many pesticide formulations can be destroyed by reaction with an appropriate acid, alkali, oxidizing agent, or reducing agent. Much caution is required in performing such degradations because, in some cases, the use of the wrong chemical on a given pesticide could produce a more toxic mixture, or an explosive mixture; or might generate toxic vapors from an ordinarily nonvolatile pesticide. The speed of the reaction with a given chemical may vary greatly for different pesticides (and even with a given pesticide in different formulations) so that one cannot easily tell when degradation is complete. The products of the degradation reaction may still be toxic to humans, animals, fish or vegetation, even though they no longer are good pesticides. Furthermore, chemical degradation methods always leave a material or liquid which must be ultimately disposed of by pouring on the ground, burial, discharge to sewer, dumping or other methods. The layman should make no attempt to conduct chemical detoxification reactions:

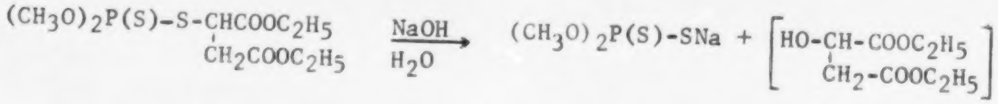
1. If any of the extremely toxic pesticides are involved; or

2. If substantial amounts (more than 50 lb or 5 gal.) of surplus pesticides are to be disposed.

The authority may furnish the layman with information on the relative amounts of chemicals to use with his pesticide, based on the concentration of active ingredient actually present. The ideal in all cases would be to have an amount of agent in slight excess of that needed to react with all the pesticide, but unfortunately the amount of agent just needed to give rapid and complete degradation of the pesticide is unknown in most instances. In the absence of specific details, only very rough guidelines are given in Procedures 7 through 10.

Methods of estimating the amounts of detoxification chemicals to use are indicated by the sample problems below:

Sample Problem 1: Dispose of one quart bottle of malathion 50% EC (emulsifiable concentrate). The reference chart, Section XI, lists Disposal Procedure No. 7, treatment with alkali, as the preferred method, and the discussion of phosphorus-containing pesticides in Section VII indicates that the first step of the reaction with sodium hydroxide, NaOH would be:



$$(CH_3O)_2P(S)\text{-}S\text{-}\underset{CH_2COOC_2H_5}{CHCOOC_2H_5} \xrightarrow[H_2O]{NaOH} (CH_3O)_2P(S)\text{-}SNa + \left[\begin{array}{l} HO\text{-}CH\text{-}COOC_2H_5 \\ \quad CH_2\text{-}COOC_2H_5 \end{array}\right]$$

As a first approximation one can estimate that the density of a liquid pesticide formulation is about the same as that of water, i.e., 1 g/cc or 8.34 lb/gal.[a] Therefore the quart of pesticide would contain about 2 lb total liquid and about 1 lb[a] of malathion. The molecular weight[b] of malathion is about 330 while that of NaOH is 40.

Therefore, the 1 lb of malathion would require at least 0.12 lb of NaOH, i.e., $\left[1 \text{ lb} \times \frac{40}{330}\right]$ for reaction, and a minimum of 1/3-1/2 lb of NaOH should be used to provide an excess in line with the information in Section VII. If flake caustic is used, it could be mixed first with about a pint of water, or if a 10% NaOH solution is available, about 2 qt of it should be used. Alternatively, if lime (CaO; molecular weight 56) is used as the alkali, 1/2-3/4 lb should be used. The pesticide and proper amount of reagent should be mixed according to the guidelines given in Procedure 7 and the mixture buried in accord with Procedure 11.

Similarly, 0.5 lb of trichlorfon (an organophosphate of molecular weigh 257) should be degraded with 1/4-1/3 lb NaOH.

Sample Problem 2: Dispose of a 50-lb bag of Sevin® 50% WP (wettable powder). From the cross-index Sevin® is seen to be the trade name for carbaryl, and the reference charts in Section XI and the supplemental information in Section VII indicate that carbaryl can be degraded by treatment with alkali, with the first step as follows:

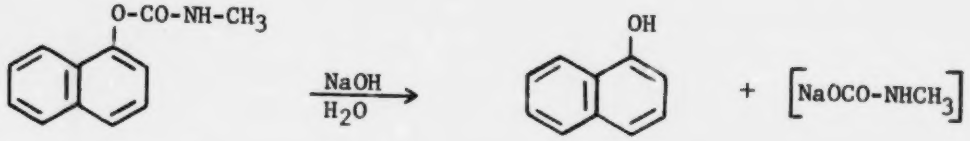
---

a/ The densities of the pure organophosphate liquids, such as 100% malathion, are about 20% greater than that of water; a 50% liquid concentrate may have a density about 10% greater than that of water.

b/ The molecular weight is the sum of the atomic weights of all the atoms in the molecule. Approximate atomic weights of atoms frequently encountered in pesticides or in disposal chemicals include:

H	1	Na	23	Ca	40	Sn	119
B	11	P	31	As	75	Hg	200.5
C	12	S	32	Br	80	Pb	207
N	14	Cl	35.5				
O	16						
F	19						

For malathion, the elemental composition (see structure above) is $C_{10}H_{19}O_6S_2P$ and the molecular weight is calculated: $10 \times 12 + 19 \times 1 + 6 \times 16 + 2 \times 32 + 1 \times 31 = 330$. (Very roughly, molecular weights can be approximated as 100 for small molecules, 200 for larger organics without P , and 300 for larger organophosphates and chlorinated hydrocarbons.)



The 50-lb bag would contain 25 lb of carbaryl (molecular weight 201) which would need at least 5 lb, i.e., of NaOH (flake caustic), $\left[25 \times \frac{40}{201}\right]$ for reaction, and one should use 10 lb to meet the guideline given in Section VII.

Sample Problem No. 3: Dispose of 1 gal. of 33% Vapam® liquid. Vapam® is a trade name (see cross-index) for metham, a dithiocarbamate soil fumigant. It is toxic to plants and animals and upon dilution with water, it slowly releases the irritating gas methylisocyanate, according to Section VII. Disposal Procedure No. 8, Treatment with Acid, is seen to be the preferred method, and the degradation would be:

$$CH_3\text{-NH-C-S-Na} + HCl\ (\text{excess}) \xrightarrow{H_2O} CH_3NH_2\ HCl + CS_2 + NaCl$$

The 1 gal. of Vapam® would contain about 3.2 lb* of actual metham (molecular weight, 129) and would require at least 0.9 lb of actual HCl (molecular weight, 36.5) to give a 1:1 reaction ratio, and about 2.5 lb should be used according to the information given in Section VII. This amount would require approximately 0.9 gal. of 30% hydrochloric (muriatic) acid (2.9 lb HCl/gal.). Alternatively, if sulfuric acid (molecular weight, 98) is used, about 6.5 lb H_2SO_4 is required or 3.5 gal. of 20% acid (1.9 lb H_2SO_4/gal.). (Concentrated H_2SO_4 should not be recommended to the layman.) Caution: The mixing should be done slowly and carefully because the 1.9 lb CS_2 that would be produced is a fire hazard.

Sample Problem No. 4: Dispose of 1 lb of Cyanogas® granules. Cyanogas® is the registered trademark for a product (see cross-index) which contains calcium cyanide, a source of extremely toxic hydrogen cyanide according to Section VII. Disposal Procedure No. 9, Treatment with Oxidants, is the preferred method and according to Section VII the first step of the reaction with sodium hypochlorite would be:

$$Ca(CN)_2 + 2NaClO \xrightarrow[H_2O]{NaOH} Ca(CNO)_2 + 2NaCl$$

---

* The density of the 33% solution can be estimated as about 15% greater than water, therefore: 1 gal. x 8.34 lb/gal x 1.15 x 33% = 3.2 lb metham.

Commercial household bleach contains over 5% $NaClO$ in excess base ($pH \sim 12$) and is directly usable for the oxidation. The 1 lb of $Ca(CN)_2$ (molecular weight, 92) would require a minimum of 1.6 lb of $NaClO$ (molecular weight, 74.5), i.e., $\left[1 \times \frac{74.5}{92} \times 2\right]$ or about 31 lb (3.5 gal.) of "bleach."

The product cyanate is objectionable in large amounts, but could be completely destroyed by a threefold excess of hypochlorite, according to Section VII, i.e., by 10 gal. of bleach per pound of $Ca(CN)_2$.

Alternatively, if the oxidant selected is bleaching powder, "calcium hypochlorite" (30-35% available chlorine, or average molecular weight[a] of about 120), a minimum of 2.6 lb are needed and nearly 8 lb are needed for complete degradation. Caution: Add water to bleaching powder before mixing it with organics.

Sample Problem No. 5: Dispose of 5 gal. of sodium chlorate, 2 lb/gal defoliant. The reference chart, Section XI lists, Disposal Procedure No. 10, Treatment With Reducing Agents, as an alternate procedure. Section VII indicates that sodium chlorate, $NaClO_3$, can be reduced with sodium thiosulfate (the photographers "hypo" reagent) in acid media. The reaction would be approximately[b] as follows:

$$4NaClO_3 + 3Na_2S_2O_3 + 3H_2O \xrightarrow{H_2SO_4} 4NaCl + 6NaHSO_4$$

The 5 gal. of chlorate solution would contain 10 lb of $NaClO_3$ (molecular weight, 106.5) and would require about 17.5 lb of thiosulfate crystals, $Na_2S_2O_3 \cdot 5H_2O$ (molecular weight, 248) $\left[\text{i.e., } 10 \times \frac{248}{106.5} \times \frac{3}{4}\right]$. The thiosulfate can be added slowly to the chlorate solution and the mixture should then be acidified slowly with 30% hydrochloric acid (about 1.5 gal. would be needed for optimum acidity, but degradation will probably proceed with 0.5 gal.). Other reducing agents are less appropriate. For example, if sodium bisulfite or ferrous sulfate (noted in Section VII) were considered as the reducing agents, the amounts required would be prohibitively large, i.e., about 30 lb and 90 lb, respectively. The $NaHSO_3$ could also evolve toxic SO_2 fumes if mixed in large excess with acid. Combinations of metal turnings or powder (e.g., iron, aluminum, or zinc) with dilute acid may be erratic or may generate excess gaseous hydrogen (which may form explosive mixtures if not well ventilated); potassium iodide is too expensive and would leave undesired residual iodine.

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[a] Bleaching powder has approximately the composition, $Ca(ClO)Cl$, but also contains some $Ca(OH)_2$.

[b] The products of the oxidation may be pH dependent, e.g., oxidation of $S_2O_3^=$ under some conditions yields $S_4O_6^=$, while $S_2O_3^=$ forms free sulfur and HSO_3^- upon standing in acid media.

Small amounts of $NaClO_3$ (50 lb or less actual) can be more easily and safely disposed of by burial (Procedure No. 11) or dilution (Procedure No. 13) the preferred procedures.

Procedures 11 and 12: These two methods involve ground disposal, i.e., burial within the top few feet of the soil or spreading on the ground surface, respectively. (Methods which are unavailable to the laymen, such as deep-well or a lined-lagoon disposal, are excluded.) Ground-disposal methods are often more suitable for the small amounts of pesticides which the individual homeowner or layman may have than for the large amounts which may accumulate at a central collection point or be on hand at industrial sites; the small amounts in isolated locations are generally subject to more effective degradation by soil organisms (aerobic or anaerobic), air oxidation, hydrolysis and photochemical decomposition. Ground disposal is often the final step in several of the other disposal procedures, such as chemical degradation or the sanitary landfills used by many companies and municipalities.

Examples of pesticides which could be directly disposed of by Procedure 11 include compounds of arsenic, boron, copper, sulfur, creosote, oils, and more than 50 synthetic organics of low hazard. Examples of pesticides that could be disposed by Procedure 12 (as well as by Procedure 11) include such liquid fumigants as carbon disulfide and ethylene dichloride and very small quantities (a few ounces) of the majority of all pesticides.

Procedures 13 and 14: These two methods involve controlled release techniques, i.e., dilution/discharge and air discharge, respectively. They may be used for the disposal of a few nonpersistent, relatively nontoxic pesticides; and, if properly performed, should not pose a hazard to man or the environment in these cases.

Examples of pesticides for which Procedure 13 is the preferred method with sizable amounts (e.g., 50 lb) are limited to just a few nonhazardous materials, such as *Bacillus thuringiensis* and butoxypolypropylene glycol. Procedure 11 can be used for smaller amounts (< 1 lb) of many other pesticides of low toxicity and environmental hazard. Procedure No. 14 is applicable to very volatile compounds (compressed gases) or aerosol formulations. It is the preferred method only for pesticide products of low hazard such as ethylene oxide or pyrethrins aerosols, but could be used as an alternate method for very small amounts of the fumigant, methyl bromide, and on most household aerosols.

Procedures for Mixed Pesticides

Specific disposal procedures are not recommended for all "mixed pesticides," i.e., products that contain two or more active ingredients, for the reasons discussed on p. 21. The determination of the best disposal method has to be made on a case-by-case basis and requires some common sense judgments in evaluating the relative importance of the concentrations and properties (toxicities, persistence, reaction chemistries) of the chemicals present, the potential disposal methods that are available for each active ingredient, the nature of the formulation, and possibly other factors. Several sample problems illustrate how this manual can be used in selecting a method.

Mixed Pesticide Sample Problem 1: Dispose of 1 qt of household bug killer that contains 5% DDT, 4% organic thiocyanates and 50% oils. DDT cannot be readily degraded chemically and is environmentally persistent; the preferred disposal method is incineration (Procedure 5) and suggested alternate methods are to turn it in to a collection agency, the manufacturer or a disposal service (Procedures 1-3); the organic thiocyanates can also be incinerated or "turned in," and can, in addition, be degraded by alkaline hypochlorite (Procedure 9). Oils can be allowed to break down in the ground or can be incinerated. Hence, the best solution to the problem would be to place it in the hands of someone that could incinerate it. However, since the total quantity is small and the concentration of DDT (and also the thiocyanates) is low, the layman could dispose of it by ground burial (Procedure 11), or by diluting the pesticide with a flammable solvent and burning the resulting mixture (Procedure 6), where burning is permissible. Disposal with the trash (Procedure No. 4) might be the best available solution in this instance for someone that cannot utilize any of the above procedures.

Mixed Pesticide Sample Problem 2: Dispose of 5 gal. of weed killer that contain 1% bromacil, 1% 2,4-D ester, 1% pentachlorophenol and 95% oil. The preferred and alternate (in parentheses) disposal procedures are: bromacil, 5 (6); 2,4-D, 5 (7,12); and pentachlorophenol, 5 (1-3). Hence, incineration is preferred. Because of the low concentrations and only moderate toxicities of the active ingredients, the layman could dispose of the pesticide by ground burial (Procedure 11) or by burning it with a flammable solvent (Procedure 6), provided precautions are taken not to harm valuable vegetation with any herbicide-containing fumes.

Mixed Pesticide Sample Problem 3: Dispose of 25 lb fungicide-insecticide dust that contains 50% sulfur and 2% parathion. The sulfur is of very low toxicity and of little environmental hazard, and could be disposed of simply by ground burial or simple ground surface disposal (Procedures 11 and 12), but the parathion is an extremely toxic material for which the preferred disposal procedure is to "turn it in" (i.e., Procedures 1-3). In this instance, however, the parathion is present in low concentration (0.5 lb total) and in a solid formulation that further minimizes its hazard. Parathion can be hydrolyzed slowly, the basis for the suggested alternate disposal method (Procedure No. 7, Treatment With Alkali) and in the present case, the layman could conveniently dispose of this product by mixing it with lime or lye and burying it according to Procedures 7 and 11.

Mixed Pesticide Sample Problem 4: Dispose of two 5-gal. drums of bagworm spray that contains 18% malathion and 40% toxaphene. Malathion is an organophosphorus compound of moderate toxicity which can be decomposed by alkaline hydrolysis (Procedure No. 7), while toxaphene is a toxic chlorinated hydrocarbon for which the preferred disposal method is incineration (Procedure No. 5). Procedures 1-3 are suggested as alternate disposal methods for both compounds, and would be the recommended method in this case. The product could also be incinerated in appropriate equipment (Procedure No. 5). The text on toxaphene (Section VII) notes that it is dehydrochlorinated in alkali and, although the environmental implications of this reaction are uncertain, burial with alkali (lime or lye) may be the best alternative for those without access to better methods. (Each of the two 5 gal. quantities should be treated separately.)

DISPOSAL PROCEDURE NO. 1

TURN IN TO PESTICIDE COLLECTION CENTER

Facilities are available in some areas for the collection, storage and proper disposal of surplus and unwanted pesticides. This procedure is the one to use if such facilities are available. A list of these facilities and their locations is not available: the list is probably small and changing, but the number may be increasing. Information on the availability of these facilities in your area can be obtained from the U.S. Government Environmental Protection Agency: addresses and telephone numbers of Regional EPA offices are listed below.

Region	Address
I	Environmental Protection Agency John F. Kennedy Federal Building, Room 2304 Boston, Massachusetts 02203 617-223-7210 (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut)
II	Environmental Protection Agency 26 Federal Plaza New York, New York 10017 212-264-8958 (New York, New Jersey, Puerto Rico, Virgin Islands)
III	Environmental Protection Agency 6th & Walnut Philadelphia, Pennsylvania 19106 215-597-9875 (Pennsylvania, West Virginia, Maryland, Delaware, District of Columbia, Virginia)
IV	Environmental Protection Agency Suite 300 1421 Peachtree St., N.E. Atlanta, Georgia 30309 404-526-3454 (North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Alabama, Mississippi, Florida)
V	Environmental Protection Agency 1 North Wacker Drive Chicago, Illinois 60606 312-353-5756 (Michigan, Wisconsin, Minnesota, Illinois, Indiana, Ohio)
VI	Environmental Protection Agency 1600 Patterson Street Suite 1100 Dallas, Texas 75201 214-749-1461 (Texas, Oklahoma, Arkansas, Louisiana, New Mexico)

Region	Address	Region	Address
VII	Environmental Protection Agency 1735 Baltimore Avenue Kansas City, Missouri 64108 816-374-3036 (Kansas, Nebraska, Iowa, Missouri)	IX	Environmental Protection Agency 100 California Street San Francisco, California 94111 415-556-0218 (California, Nevada, Arizona, Hawaii)
VIII	Environmental Protection Agency 1860 Lincoln Street Denver, Colorado 80203 303-837-3849 (Colorado, Montana, Wyoming, Utah, North Dakota, South Dakota)	X	Environmental Protection Agency 1200 6th Avenue Seattle, Washington 98101 206-442-1296 (Washington, Oregon, Idaho, Alaska)

Other potential sources of information in your area are:

County extension agents or county agricultural commissioner.

City water pollution control officials.

City public health department.

State Department of Agriculture or Commissioner of Agriculture.

State Department of Natural Resources, Conservation, or Forest and Parks.

State Pesticide Board or Board of Pest Control.

State Water Pollution (or Resources) Control Board.

State Department of Public Health, or Division of Health.

State Department of Public Works.

U.S. Government Department of Agriculture, local offices.

DO NOT

Send or take any pesticide to any agency without first getting its O.K.

DO NOT

Attempt to set up a pesticide collection center on your own.

DO

Leave the pesticide in the original container unless it is leaking.

DO

If you know, tell the people at the collection site the age and name of the pesticide in each container.

DISPOSAL PROCEDURE NO. 2

RETURN TO SUPPLIER

Some pesticide suppliers will accept the return of unwanted pesticides that they sold. This method is good for all types and quantities of unwanted material. FIRST, contact the supplier;* tell him exactly what and how much pesticide you have. Then, if he will take back the pesticide, or if he tells you where to take it, unopened containers can be returned the same way they were shipped to you.

If repackaging is required, the federal regulations on shipping hazardous material must be followed, and these must be determined in each individual case. Contact the U.S. Government Department of Transportation, Office of Hazardous Materials for this information, or ask local environmental officials for assistance in contacting the Department of Transportation about your particular pesticide. Railroads and truck freight line companies usually have information pertinent to the shipping of hazardous materials.

DO NOT

Send or take any pesticide to the supplier without first getting his O.K.

DO NOT

Ship any repackaged pesticide without first checking with the U.S. Department of Transportation or other authorities.

DO NOT

Send pesticides in breakable containers (glass bottles, paper bags or cardboard cartons) unless they are securely packaged in a box suitable for shipment.

DO

Leave the pesticide in the original container (unless it is leaking).

---

* Each pesticide and supplier must be considered separately: the public official supplying this disposal procedure has available a list of the addresses and telephone numbers of the major pesticide manufacturers.

DISPOSAL PROCEDURE NO. 3

TURN IN TO INDUSTRIAL WASTE SERVICE

In many communities, companies that will dispose of pesticides are available. These companies are of three types: chemical waste processors; chemical manufacturers; or commercial landfill operators.

The chemical waste processor may accept all types of industrial chemicals for disposal, reclamation or reprocessing. He might be variously listed in the telephone directory under categories such as:

Chemical disposal, removal, reclamation or conservation;

Waste disposal or reduction;

Industrial chemical treatment; and

Liquid waste or pollution control.

Local inquiry will be needed to identify disposal services of this type in your area.

Many chemical manufacturers frequently handle hazardous materials and are well equipped to dispose of such materials on a regular basis. Local inquiry should be made to determine if small quantities of pesticides would be accepted.

Some commercial landfill operators have facilities approved for disposition of pesticide wastes, and provide service for local manufacturers of formulators. Local inquiry should be made.

DO NOT

Send or take any pesticides to any company without first getting its O.K.

DO

Leave the pesticide in the original containers unless it is leaking.

DO

Remember to tell the recipient (particularly if he is a landfill operator) that your material is a pesticide.

DISPOSAL PROCEDURE NO. 4

PLACE IN TRASH FOR PICK-UP SERVICE

Very small amounts of a few pesticides may be disposed of by the homeowner by way of your trash pick-up service. Local regulations (city, town or county), however, should be checked to determine if this is permitted in your area. The pesticide should be well wrapped in newspaper or pasteboard, and placed in the pick-up site immediately prior to the time of pickup. The pick-up crew should be notified that a pesticide container is in the trash.

DO NOT

Crush containers.

DO NOT

Attempt to dispose of more than 5 lb or 1 gal by this method.

DO

Determine whether your community utilizes a sanitary landfill that can handle pesticides.

DISPOSAL PROCEDURE NO. 5

INCINERATION

An incinerator capable of burning pesticides is generally not available to the layman. Such an incinerator should be fuel-fired to maintain a temperature of about 1600°F. This temperature will completely decompose pesticides, and will eliminate smoke and odors. Incomplete combustion will allow dangerous quantities of pesticide to escape to the air. The incinerator must also be equipped with a system to remove dangerous or polluting combustion products (such as sulfur dioxide and hydrogen chloride). Pesticides which contain heavy metals such as mercury or arsenic should never be incinerated unless extremely efficient pollution control equipment is used.

Very small amounts of some pesticides can be disposed of in an efficient incinerator which does not have a scrubber system in areas where incineration is permitted.

DO NOT

Use an indoor or basement incinerator.

DO NOT

Incinerate aerosol cans.

DO NOT

Incinerate herbicides during the growing season unless a highly efficient incinerator is available.

DO

Find out if incineration is permitted in your area.

DO

Have an experienced person operate the incinerator.

DISPOSAL PROCEDURE NO. 6

BURNING

Burning is the best available method of disposing of some pesticides. Burning should be done in a shallow depression well away from any buildings, animals, or susceptible vegetation. The pesticide should be mixed with a flammable solvent if it is not already formulated with one.

Kerosene or Diesel Fuel No. 1 is available at auto service stations. Mineral spirits and VM&P Naphtha are widely available at hardware and paint stores. Wood alcohol (methanol), denatured alcohol (often used as shellac thinner) and isopropyl alcohol (which is frequently sold as a 70% aqueous solution) are also widely available. These alcohols may dissolve pesticides not readily soluble in kerosene.

Naphtha (VM&P), denatured alcohol, and wood alcohol tend to make less smoke than kerosene, diesel oil, or mineral spirits, and much less smoke than aromatic solvents.

The pesticide-solvent mixture should be poured onto an absorbent material such as splintered wood, excelsior, ground corncobs, or paper heaped onto a gravel and sand base. The mixture should be ignited by means of an excelsior train at least several feet long. Stay on the upwind side and keep children or animals away until the fire has died down. Cover the ashes with dirt.

DO NOT

Burn large amounts at one time.

DO NOT

Burn aerosol cans.

DO NOT

Burn herbicides during the growing season.

DO

Find out if open burning is permitted in your area.

DISPOSAL PROCEDURE NO. 7

TREATMENT WITH ALKALI

Many pesticides are decomposed when treated with alkali (or basic) chemicals, such as lye or lime. The alkali chemicals that are readily available are discussed briefly below.

Soda ash (sodium carbonate), also called sal soda and washing soda, is fairly caustic, but is not as strong and is less hazardous than lye (sodium hydroxide), often called simply caustic soda. Baking soda (sodium bicarbonate) is midly alkaline, as is household ammonia. These chemicals are readily available from hardware, grocery, or drug stores. Slaked lime (calcium hydroxide) is a strong alkali, and lime water is a diluted solution of this compound. Lime (calcium oxide) is also strongly alkaline and is somewhat more irritating to the skin. Limestone (calcium carbonate) is a very mild alkali. These three calcium compounds all have low solubility in water and do not leach out of the ground as rapidly as lye or soda ash and give residual alkalinity. They are available from hardware or garden supply stores. Trisodium phosphate is also fairly caustic and is available at paint stores.

The preferred procedure is to mix the pesticide with excess lime or lye and sand or other absorbent in a pit or trench at least 18 in. deep in a clay soil. Lye (or soda ash) can also be added to the mixture to help speed the reactions when lime is used as the main alkali.

The amount of lime or lye to use depends on the amount of pesticide to be disposed of and, to some extent, the concentration of active ingredient in the pesticide and the actual chemical nature of the active ingredient. A practical guideline, in the absence of specific directions, is to use an approximate volume or weight of alkali from one-half of to the same as that of the pesticide. For example, for 1/2 lb or 1 quart of an organophosphate pesticide, one might use either 1/4 lb of flake caustic, 1/2 lb of lime or about 2 qt of a 10% lye solution. For dilute pesticide formulations, such as a 1% solution or dust, the amount of lime or lye can be reduced by one-half. For very concentrated pesticides (over 80% active ingredient) the amount of lime or lye can be doubled, but the concentrate should be mixed first with water (or soapy water) before reaction with the alkali. For safety, a preliminary test should be made in which very small amounts of the pesticide and alkali are mixed and observed briefly to make sure it does not react too vigorously. Sizable quantities of pesticides, such as a 50-lb bag or a 5-gal. drum, can be disposed of in several smaller batches, rather than all at once, for added safety.

The pit or trench should be sufficiently large to accept the pesticide and the degradation chemicals. For each 1 gal. of total liquid or each 10 lb of total solid, a trench 6 in. wide (at the bottom) and 2 to 3 ft long should be adequate. The mixture should then be covered with dirt (see Disposal Procedure No. 11).

DO NOT

Dispose of pesticides or the reaction mixtures in an area where groundwaters can be contaminated.

DO NOT

Leave reaction mixtures unattended until they have been covered over with earth. Never return a reaction mixture to the pesticide storage shed.

DO NOT

Conduct chemical detoxifications in tightly sealed containers (a loose cover can be provided).

DO NOT

Mix two or more pesticides before disposal: (treat each one separately).

DO

Exercise safety precautions; work out-of-doors and away from buildings. Mix pesticides and chemicals slowly. Avoid any fumes. Rubber gloves, a rubber apron, and safety glasses should be worn. Alkalis are corrosive to skin. Wash up thoroughly and promptly.

DISPOSAL PROCEDURE NO. 8

TREATMENT WITH ACID

Certain pesticides are degraded by mixing with acids. Available acids include: Muriatic acid (approximately 30% hydrochloric acid) is widely used in treating concrete and masonry surfaces, and is available from many hardware stores. Sulfuric acid (20%) is also available in the form of several drain cleaner products. Caution: These acids are extremely corrosive.

Sodium bisulfate is less strongly acidic (often used as bathroom bowl cleaners). Alum (aluminum sulfate) is also weakly acidic and is of lower solubility in water. Sal ammoniac (ammonium chloride), which is often used in soldering fluxes is available from hardware stores, and gives mildly acidic solutions. The sodium bisulfate, alum and sal ammoniac may not be strong enough to degrade many pesticides as efficiently as would sulfuric or muriatic acids, and the latter two are preferred as a first treatment. The alum or sodium bisulfate can be added to the nearly completed reaction mixture to provide residual acidity for extra safety, if desired.

The reactions usually proceed more rapidly in solution (such as by stirring in a plastic container with excess muriatic acid), but this method is somewhat hazardous. The preferred method is to mix the pesticide with sand (or other absorbent) in a pit or trench at least 18 in. deep in a clay soil and then add the acid.

The amount of acid to use depends on the amount of pesticide to be disposed of and, to some extent, the concentration of active ingredient in the pesticide and the actual chemical nature of the active ingredient. A practical guideline, in the absence of specific directions, is to use an approximate volume (in gallons) of acid from one-fourth to one-half of the weight (in pounds) of the pesticide formulation. For example, for 1 lb of a pesticide one might use 1/4 gal. of a 30% muriatic acid or 1/2 gal. of 20% sulfuric acid solution. For dilute pesticide formulations, such as a 1% solution or dust, the amount of acid can be reduced by one-half. For very concentrated pesticides (over 80% active ingredient) the amount of acid should be doubled, but the concentrate should be mixed first with water before reaction with the acid. For safety, a preliminary test should be made in which very small amounts of pesticide and acid are mixed and observed briefly to make sure the reaction is not too vigorous. Sizable quantities of pesticides, such as 50 lb or 5 gal., can be disposed of in several smaller batches, rather than all at once for added safety.

The pit or trench should be sufficiently large to accept the pesticide and the degradation chemicals. For each 1 gal. of total liquid or each 10 lb of total solid, a trench 6 in. wide (at the bottom) and 2 to 3 ft long should be adequate. The mixture should then be covered with dirt (see Disposal Procedure No. 11).

DO NOT

Dispose of pesticides or the reaction mixtures in an area where groundwaters can be contaminated.

DO NOT

Leave reaction mixtures unattended until they have been covered over with earth. Never return a reaction mixture to the pesticide-storage shed.

DO NOT

Conduct chemical detoxifications in tightly sealed containers (a loose cover can be provided).

DO NOT

Mix two or more pesticides before disposal: treat each pesticide separately.

DO

Exercise safety precautions; work out-of-doors and away from buildings. Mix pesticides and chemicals slowly. Avoid any fumes. Rubber gloves, a rubber apron, and safety glasses should be worn. Acids are corrosive to skin. Wash up thoroughly and promptly.

DISPOSAL PROCEDURE NO. 9

TREATMENT WITH OXIDANTS

Certain pesticides can be degraded by treatment with oxidizing agents, such as sodium hypochlorite solution (liquid household bleach) or calcium hypochlorite (bleaching powder or chlorinated lime, often available at swimming-pool supply stores). Household liquid bleach contains about 5% sodium hypochlorite, but a 14% commercial strength product is available at chemical supply houses. The pesticide and bleach could be stirred in a metal or plastic container, but this procedure is somewhat hazardous. The preferred method is to mix the pesticide with sand or other absorbent in a pit or trench in clay soil at least 18 in. deep and then add bleach.

The amount of bleach to use depends on the amount of pesticide to be disposed of and, to some extent, the concentration of active ingredient in the pesticide and the actual chemical nature of the active ingredient. A practical guideline, in the absence of specific directions, is to use about 2 gal. of liquid household bleach (or 1 lb of bleaching powder) per pound of pesticide. (Some pesticide manufacturers recommend use of the 14% bleach with added sodium bicarbonate (baking soda) at 1/2 lb/gal). For dilute pesticide formulations, such as a 1% solution or dust, the amount of bleach can be reduced by one-half. For very concentrated pesticides (over 80% active ingredient) the amount of oxidant can be doubled. If the bleaching powder is used, it should be mixed first with water, 1 gal/lb. For safety, a preliminary test should be made in which very small amounts of pesticide and oxidant are mixed and observed briefly to make sure the reaction is not too vigorous. Sizable quantities of pesticides, such as 50 lb or 5 gal., can be disposed of in several smaller batches rather than all at once for added safety.

The pit or trench should be sufficiently large to accept the pesticide and the degradation chemicals. For each 1 gal. of total liquid or each 10 lb of total solid, a trench 6 in. wide (at the bottom) and 2 to 3 ft long should be adequate. The mixture should then be covered with dirt (see Disposal Procedure No. 11).

Hydrogen peroxide, another liquid oxidant, is less appropriate for the disposal of pesticides as are some of the more expensive bleaching powders. Solid oxidants, such as ammonium nitrate (a fertilizer) and sodium chlorate (a herbicide), should not be mixed directly with organic pesticides, because such mixtures constitute fire or explosion hazards. (Solutions of these oxidants in water are less hazardous.) Also, these oxidants should never be mixed with bleach.

DO NOT

Dispose of pesticides or the reaction mixtures in an area where groundwaters can be contaminated.

DO NOT

Leave reaction mixtures unattended until they have been covered over with earth. Never return a reaction mixture to the pesticide-storage shed.

DO NOT

Mix large (> 1 gal.) quantities of pesticide and bleach (or other oxidant) at one time.

DO NOT

Conduct chemical detoxifications in tightly sealed containers (a loose cover can be provided). Do not mix two or more pesticides before disposal (treat each one separately).

DO

Exercise safety precautions; work out of doors and away from buildings. Mix pesticides and chemicals slowly. Avoid any fumes. Rubber gloves, a rubber apron, and safety glasses should be worn. Acids, alkalis, and oxidants are corrosive to skin. Wash up thoroughly and promptly.

DISPOSAL PROCEDURE NO. 10

TREATMENT WITH REDUCING AGENTS

A few pesticides (such as sodium chlorate) can be degraded by treatment with chemical-reducing agents, such as sodium thiosulfate (photographer's hypo solution) in the presence of acid. The pesticide and reducing agent could be stirred in a plastic container. However, the preferred method is to mix the pesticide, reducing agent and acid with sand or other absorbent in a pit or trench at least 18 in. deep.

The amount of reducing agent to use depends on the amount of pesticide to be disposed of and, to some extent, the concentration of active ingredient in the pesticide and the actual chemical nature of the active ingredient. A practical guideline, in the absence of specific directions, is to use a weight of reducing agent and acid approximately equal to that of the pesticide. For example, for 1 lb of a sodium chlorate formulation, one might use 1 lb of sodium thiosulfate crystals (sodium bisulfite is another reducing agent that may be available to you, but one must use about twice the amount recommended above).

The pesticide and reducing agent are mixed and 1/2 gal. of 30% hydrochloric (muriatic) acid is added slowly. For dilute pesticide formulations, such as a 1% solution, the amount of reducing agent can be reduced by one-half. For more concentrated pesticides, use about 1.75 lb thiosulfate for each pound of actual sodium chlorate in the formulation. Sizable quantities of pesticide (such as 50 lb) should be disposed of in several small batches.

The pit or trench should be sufficiently large to accept the pesticide and the degradation chemicals. For each 1 gal. of liquid or each 10 lb of solid, a trench 6 in. wide (at the bottom) and 2 to 3 ft long should be adequate. The mixture should then be covered with dirt (see Disposal Procedure No. 11).

DO NOT

Dispose of pesticides or the reaction mixtures in an area where groundwaters can be contaminated.

DO NOT

Leave reaction mixtures unattended until they have been covered over with earth. Never return a reaction mixture to the pesticide storage shed.

DO NOT

Conduct chemical detoxifications in tightly sealed containers (a loose cover can be provided).

DO NOT

Mix two or more pesticides before disposal: treat each one separately.

DO

Exercise safety precautions; work out-of-doors and away from buildings. Mix pesticides and chemicals slowly. Avoid any fumes. Rubber gloves, a rubber apron, and safety glasses should be worn. Acids are corrosive to skin. Wash up thoroughly and promptly.

DISPOSAL PROCEDURE NO. 11

BURIAL IN THE GROUND

Disposal of small amounts of some pesticides can be accomplished by burying in the ground, either directly or after a preliminary treatment such as chemical degradation (Procedures 7, 8, 9 or 10). The pesticide should be mixed with a portion of soil which is rich in organic matter or decaying vegetation. Sand or other absorbent should be added if the pesticide is a liquid. The mixture should be buried at least 18 in. deep in a pit or trench in clay soil. The size of the pit or trench that is needed depends on the amount of pesticide (or pesticide plus chemicals) that is to be disposed of. For each 1 gal. of liquid or each 10 lb of solid to be disposed, a trench 6 in. wide (at the bottom) and 2 to 3 ft long should be sufficient. The pesticide or mixture should then be covered with earth. The earth cover should be tightly packed and mounted up so that water will run off. The burial site should be on a flat or slightly elevated ground where it is not subject to erosion or leaching and percolation into underground waters. The water table should be at least 5 ft below ground at the burial site and areas near springs or wells should be avoided.

DO NOT

Bury in a location where the pesticide may get into groundwater supplies Do not bury large amounts of pesticide at one location. Do not bury in a yard without concealing the fresh earth, which might attract children or pets to dig at that site.

DO

Determine if burial is permitted in your community. Do maintain a map or record showing burial sites so that they will not be dug up accidentally or used as a site for planting food crop or ornamental vegetation.

DISPOSAL PROCEDURE NO. 12

GROUND SURFACE DISPOSAL

Small amounts of some pesticides can be disposed of by spraying on bare-ground, yard, noncropland, or land which is not being used for grazing. When this procedure is used, the thinly spread pesticide is subjected to rapid breakdown by biodegradation, sunlight, air and moisture. The area selected should be level, or slightly elevated, well-away from ditches or water holes, and remote from buildings or sensitive vegetation. The pesticide should be applied, in general, according to the directions on the label of the container. (It should not be applied to crops for which the use has been cancelled.)

For a very few pesticides of low toxicity and low persistence, small amounts may be simply diluted and poured on the surface of porous soil, or this may be done after chemical degradation (Procedures 7, 8, 9 or 10) of the pesticide.

DO NOT

Spray on cropland or vegetation which may be eaten soon by animals.

DO NOT

Dispose of persistent chlorinated insecticides, such as DDT, by this method.

DO NOT

Dispose of mercury pesticides by this method.

DO NOT

Attempt to spray pesticides that have been treated by chemical degradation agents.

DO

Use a coarse spray and avoid windy days to minimize drift of the pesticide in the air.

DISPOSAL PROCEDURE NO. 13

DILUTION

A few pesticides may be disposed by dilution and discharge to the sewer, but this procedure has numerous restrictions. In general, the pesticides for which this method is acceptable are those which are readily biodegraded in a municipal waste treatment plant or in the environment. Persistent chlorinated hydrocarbon insecticides, heavy-metal pesticides, and extremely toxic insecticides or rodenticides should not be disposed by this method. In a few instances, the pesticide might be chemically degraded by Procedures 7, 8, 9 or 10, and then diluted and discharged. Pesticides or pesticide degradation mixtures should not be discharged to a septic tank because of possible interference in its normal biological operation.

DO NOT

Dispose of any pesticide by dilution procedures unless you know (1) that the pesticide is relatively nontoxic to humans and wildlife, (2) that it is not persistent, and (3) that it is easily biodegraded.

DO

Dilute several-fold with water; detergent may also be added.

DISPOSAL PROCEDURE NO. 14

RELEASE TO THE AIR

A few pesticides may be disposed by release to the air. These are gaseous or volatile liquid fumigants which are known to be degraded in the atmosphere. If the pesticide is a volatile liquid, it may be disposed of by pouring onto sand or porous soil and allowing it to evaporate. Aerosol cans of relatively harmless pesticides can be emptied by spraying either onto the sand or into the air. Small cylinders (< 1 lb) which have valves can be slowly depressurized by leaving the valve slightly open. Larger cylinders should be returned to the manufacturer. In all cases the disposal should be performed outdoors, well away from buildings and sensitive vegetation, and with due caution to stay upwind and out of fumes or spray.

DO NOT

Spray near a fire or burn empty aerosol cans.

DO

Read the precautions on the label.

DISPOSAL OF CONTAINERS

"Empty" pesticide containers pose serious hazards to children, animals, and the environment, because these containers are never completely empty and free of pesticide residues. In fact, some pesticide formulations are such thick liquids or sticky solids that a container which has been reasonably well drained may still contain several ounces of pesticide, for example 6 oz in a 5-gal. container and 2 lb in a 55-gal. drum. Therefore, handle all pesticide containers with the same caution required for the pesticide itself. Every container should be properly disposed of after use, and should never be left unattended. A good general rule is that emptied pesticide containers should never be reused for other purposes by the homeowner, because they cannot be satisfactorily decontaminated. Another general rule is that the pesticide user can save considerable money by draining containers as completely as possible and by using the rinsings wherever possible as a pesticide, for example by applying the rinsings through the sprayer.

Metal Cans and Drums

Small empty aerosol cans which have contained pesticides, but are now depressurized, can be disposed of with household trash, or can be buried. These should not be incinerated or burned since they may contain explosive amounts of residual hydrocarbon propellant.

A small unpressurized can (up to 1-gal. size) can be rinsed with detergent solution (1-2 tablespoons in 1 pint of water) in two portions. Rotate or shake the can to wet all inner surfaces and drain. If the solution can be used for normal pesticide purposes, do so. Otherwise, dispose of the solution and the can, after it has been punctured and crushed, by burial at least 18 in. deep in a pit of clay soil as described in Procedure 11. An acid, alkali, oxidant, or reducing agent can be added to the solution to assist degradation of the pesticide, as described in Procedures 7, 8, 9 and 10, but with the small amounts involved with small containers, this is not generally necessary.

Larger metal drums (30 or 55 gal.) or cans of the 5-gal. size can be cleaned in the same manner as the 1 gal. cans, except that larger amounts of detergent are needed and chemical degradation of the rinsings is desirable if possible. Let each container drain as much as possible, and use a proper procedure (see preceding paragraph) to dispose of the pesticide. Rinse each container twice with the following: (1) 5-gal. can - 2 tablespoons detergent per quart of water; (2) 30-gal. drum - 1/4-cup detergent in 1 gal. of water; (3) 55-gal. drum - 1/2-cup detergent in 2 gal. of water.

Where chemical degradation methods (Procedures 7, 8, 9 or 10) are available, the appropriate chemical material can be added in the rinse solution. The rinse solutions should be buried as indicated for 1-gal. cans.

The 5-gal. cans should be punctured, crushed and buried deeply. A pick axe is useful for puncturing, but a chisel can be used. The 30-gal. or 50-gal. drums are difficult to puncture, crush and bury. In some communities, collection facilities have been set up to receive empty pesticide containers and, if available, these should be utilized. Alternatively, the drums should be turned in to cooperage firms which salvage metal drums by firing them at red heat. (Salvaged drums which have contained aldrin, dieldrin, etc., should go to steel mills). If a drum salvage firm is not available, then crushing and burial are necessary; do not use the drums for other purposes.

Fiber, Paper or Plastic Cartons, Bags and Containers

Containers made of combustible materials may, where local ordinances permit, be burned in accordance with the guidelines given in Procedure 6. The container can be torn or cut into pieces and pretreated with a flammable solvent (such as kerosene, diesel fuel, mineral spirits or naphtha) to make it burn better if desired. If burning is not permitted, the containers can be crushed and buried according to the guidelines given for metal containers. Trash pick-up service may be utilized in some communities to dispose of small numbers of containers (which should be crushed and bundled, wrapped or tied), and in some localities the containers might be taken directly to a sanitary landfill. Plastic pesticide containers may be rinsed before disposal, as described for metal containers.

DO NOT

Burn herbicide containers during the growing season. Do not use indoor incinerators to burn pesticide containers. Do not burn containers used for mercury, arsenic, thallium or other heavy metal pesticides. Do not reuse fiber or plastic pesticide containers for any other purpose.

DO

Remember that fumes from burning pesticide containers are dangerous to humans, animals, and sensitive vegetation. Any burning or burial methods should be performed in a remote area.

Glass Containers

Glass containers for pesticides are usually small (1 gal. or less). These may be rinsed as described for metal containers, and disposed by burial or by trash pick-up service. The bottles should be wrapped in rags, pasteboard, or several layers of newspaper, and then crushed before burial or being placed in the trash pick-up can. Large numbers of rinsed glass containers may be broken inside of an open-top disposable fiber or metal drum that can be covered and then buried or taken to a sanitary landfill. Caution: a 30-gal. drum full of broken glass is almost too heavy to handle manually. A long metal rod may be used to break bottles inside a barrel and a plastic cover may be used to prevent pieces of flying glass.

DO NOT

Break containers which still have unused pesticide in them.

DO NOT

Bury in a location that is likely to be dug up again.

DO NOT

Reuse glass pesticide containers for any other purpose.

DO

Wear safety glasses and gloves while breaking up glass containers, and exercise caution.

CLEAN UP AND TREATMENT OF SPILLS

Large spills of pesticide (more than 50 gal. or 200 lb) or spills that you can not control require the help of pesticide experts. You can call the National Agricultural Chemicals Association's pesticide safety team (513) 961-4300 at any time, and get help on dealing with a serious pesticide spill. This service will need to know your name and location, and the name and quantity of pesticide spilled, so that they can get expert help to the scene as quickly as possible.

Small spills of pesticides should be cleaned up immediately. All contaminated dirt or cleaning materials should be properly disposed of. Spills of solid pesticides on a clean floor can usually be recovered and returned to the container. Damaged containers should be repaired if possible, or placed inside a proper container which should be clearly labeled to indicate its hazardous contents.

Spills of liquid pesticides on a floor should be absorbed on dry sand, sawdust, sweeping compound, or other absorbent, which is then disposed of by procedures given for the specific pesticide. The floor should be decontaminated by washing with a strong detergent solution, or by a chemical decontaminant specified for the particular pesticide. Floor washings should be disposed of by burial as indicated in Procedure 11. Very small liquid spills should be wiped up with a cloth rag that can then be buried (see Procedure 11) or put in the trash (see Procedure 4).

Pesticide spilled on the ground should be scooped up and buried, either alone or with appropriate chemical treatment.

DO NOT

Flush spills into the sewer unless you are assured that no damage will result.

DO

Use adequate protective clothing such as rubber gloves, boots, and safety glasses as indicated on the label of the container.

DO

Cleanup shovels, brooms, or other contaminated equipment by washing thoroughly with strong detergent solution.